MECHANICAL ENGINEERING

• APRIL 1951 •

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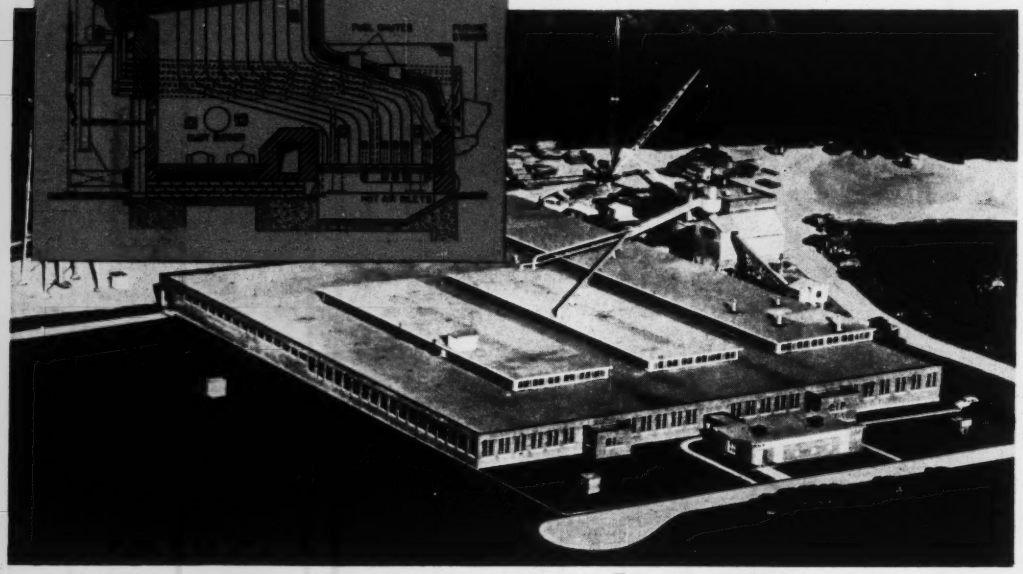
FIRST OF ITS KIND



...United States Plywood gets 4-fuel Economy with new B&W Boiler

Another Product of B&W Engineering for Economy

Believed to be the first 4-fuel boiler ever built with a fully water-cooled dutch-oven, United States Plywood's new Type H Stirling unit at Orangeburg, S. C. is designed to burn wet wood . . . and coal, oil, and gas.

Efficient firing of both low- and high-Btu fuels, with minimum maintenance to the dutch-oven walls and arch, enables this unit to do the job of two separate boilers . . . and to show an estimated 35% investment saving over an alternative two-boiler layout. Further, it occupies 30% less space than would ordinarily have been required.

Wood refuse is utilized in the form of sawdust, sanderdust, and chips. Slabs, log cores, or coal can be handfired on grates in an emergency. Provision is also made for firing coal directly into the dutch-oven by spreader stoker . . . with oil and gas, separately or in combination, through burners located at the rear of the main combustion chamber.

This sort of creative approach to boiler and fuel-burning problems—applied in close cooperation with far-sighted managements and power engineers—has identified B&W with steam-power progress for more than 80 years. It may be just what is needed to effect important economies in working out *your* steam-generating problems or plans.

BABCOCK & WILCOX

Helping Industry cut steam costs since 1867

G-482

MECHANICAL ENGINEERING, April, 1951, Vol. 73, No. 4. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price to members and affiliates one year $3.50, single copy 50¢; to nonmembers one year $7.00, single copy 75¢. Postage to Canada, 75¢ additional, to foreign countries $1.50 additional. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Member of the Audit Bureau of Circulations.

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Felts

If you have Defense Order Contracts, or subcontracts calling for the use of wool felt, get in touch with American. We can supply you with the felt to meet your specifications.

When writing, please use these felt specification numbers on your contracts.

This information is important, since in recent years there have been changes in Federal specifications for wool felts. American knows and will gladly work closely with you to see that Defense Orders for felt are filled with material that meets the requirements exactly.

Note These Two Specifications

Here are the two most important specifications for wool felt.

Specification No.	Title
Air Force Contracts	
MIL-F-5656 (Supersedes AN-F-14a) (Identical with S.A.E. Felt Specifications)	Felt Wool
All Other Contracts	
Federal Specification C-F-206 (Identical with S.A.E. Felt Specifications)	Felt Mechanical Roll

American Felt Company

TRADE MARK

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WHAT YARDSTICK DO YOU USE IN SELECTING GEARS?

On any basis of selection, Farrel-Sykes herringbone gears offer a number of advantages to designers and engineers responsible for the correct application and successful operation of gears. The quiet, vibration-free performance and long life you can expect from these gears result from extreme accuracy of tooth spacing, contour and helix angle...qualities inherent in the Farrel-Sykes method of gear generation.

The herringbone design provides a maximum number of gear teeth always in mesh. Overlap or interlacing of the teeth, together with gradual engagement, contribute to smooth operation. Opposed helices balance and absorb axial thrust within the gear member, eliminating harmful thrust loads and resultant stresses on other parts of the machine.

Farrel-Sykes herringbone gears are made of the finest grade materials, in a complete range of sizes for any power capacity and any application.

Farrel engineers are available to assist in working out unusual gear problems. Information about herringbone gears, or any of the other types mentioned on this page, will be sent on request.

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.
Plants: Ansonia and Derby, Conn., Buffalo, N. Y. • *Sales Offices:* Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Cleveland, Detroit, Chicago, Los Angeles, Tulsa, Houston, New Orleans

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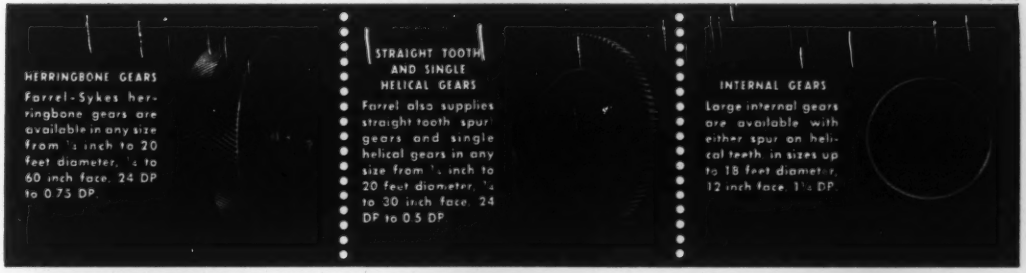
HERRINGBONE GEARS
Farrel-Sykes herringbone gears are available in any size from ½ inch to 20 feet diameter, ¼ to 60 inch face. 24 DP to 0.75 DP.
STRAIGHT TOOTH AND SINGLE HELICAL GEARS
Farrel also supplies straight tooth spur gears and single helical gears in any size from ½ inch to 20 feet diameter, ¼ to 30 inch face. 24 DP to 0.5 DP.
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Large internal gears are available with either spur or helical teeth in sizes up to 18 feet diameter, 12 inch face, 1½ DP.

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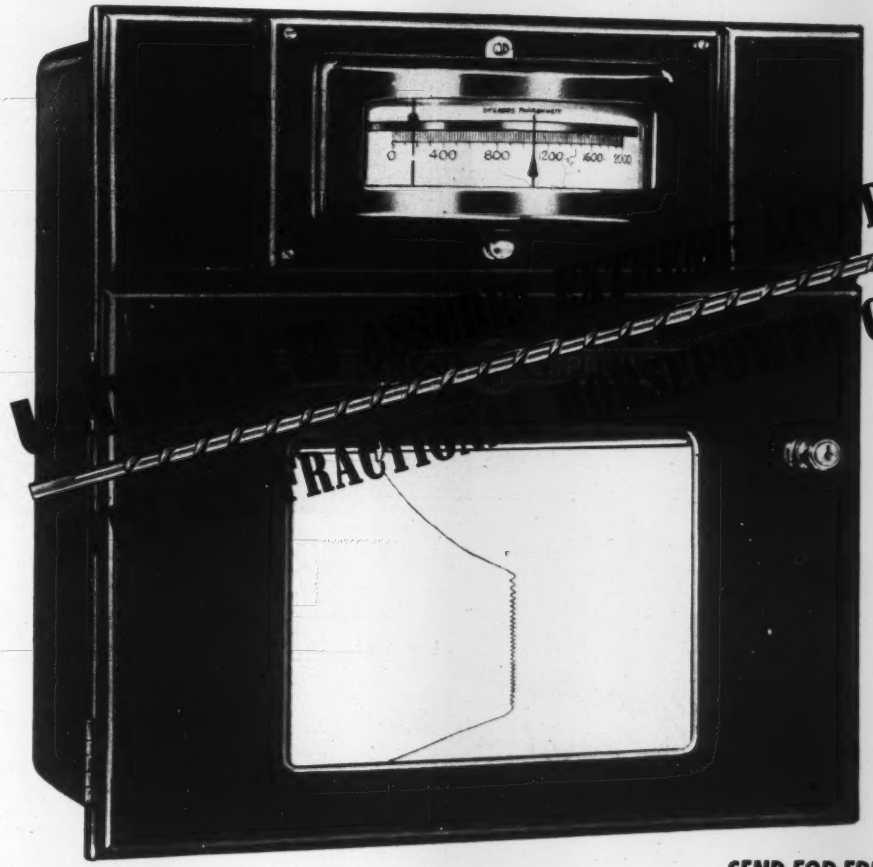
if it's a wire spring .
spring washer . . . . . .
flat spring . . . . . .
or wire form . . . . .

we make it!

Wallace Barnes Springs

Bristol Connecticut



RACY

GEARS

A Stainless Steel Lead Screw, ground from the solid, to the most exacting specifications, controls the recorder pen in the dependable, highly efficient "Capacilog" . . Wheelco's newest Strip Chart Recorder. The extreme accuracy of this fine electronic instrument is largely due to the exceptional precision and uniformity of this Lead Screw together with G.S. Fractional Horsepower Gearing. G.S. Craftsmen are justly proud of their important contribution to the success of the Capacilog.

If *better* Gearing from 12 to 96 D.P. is a consideration in your business, discuss your needs with our competent engineers. More and more particular buyers from coast-to-coast are profiting by G.S. experience. You see . . we've specialized in the economical, mass-production of *high precision* Fractional Horsepower Gearing *exclusively* for more than 30 years!

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6-page folder which illustrates and describes G.S. facilities, Small Gearing and applications together with handy charts for those who specify Gearing from 12 to 96 D.P. and finer. Will you ask for it on company stationery, please?

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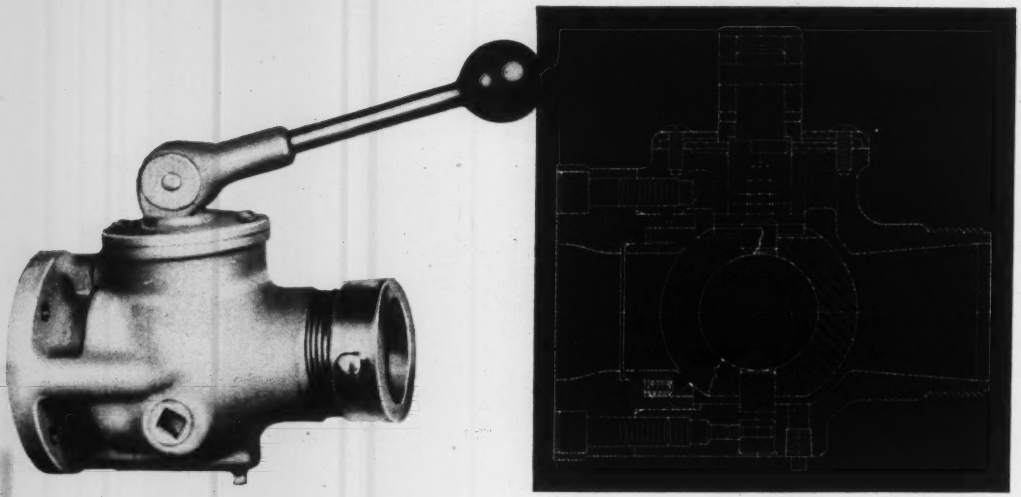

TIP...

FOR THE DESIGNER

Simplified Construction and Self-Adjusting too! with...

LINEAR PRECISION MOULDED "O" RINGS

The Waterous Company has capitalized on the merits of LINEAR "O" Rings in the advanced design of its Model 49B Gate Valve.

A total of five different LINEAR "O" Rings are used in this unique valve... simplifying construction and eliminating the irreparable wear of normal seat design. "O" Ring applications include: one as a rotary joint on the upper stem; two as static seals; one as a packing for the seal ring; and one as a self-adjusting valve seat.

This incorporation of LINEAR "O" Rings has resulted in considerable cost reduction... plus longer, more satisfactory service for the valve which must handle water at pressures up to 500 psi. at capacities up to 500 gpm.

LINEAR "O" Rings are compounded of natural or synthetic rubber, fluorethylene polymers, and silastics... are available in a complete range of J.I.C. and A.N. standard sizes, as well as hundreds of non-standard sizes for special uses.

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REFERENCE BOOK

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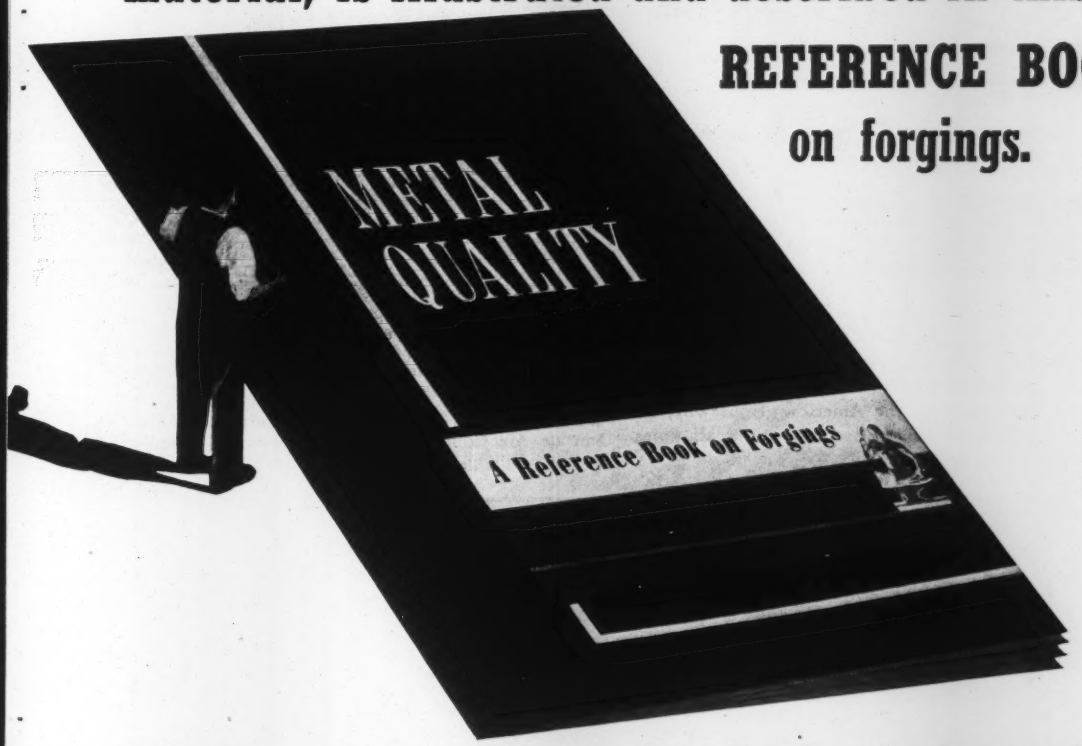

Write for a copy. Then consult a forging engineer about how you can obtain the correct combination of mechanical qualities in forgings for your particular type of equipment.

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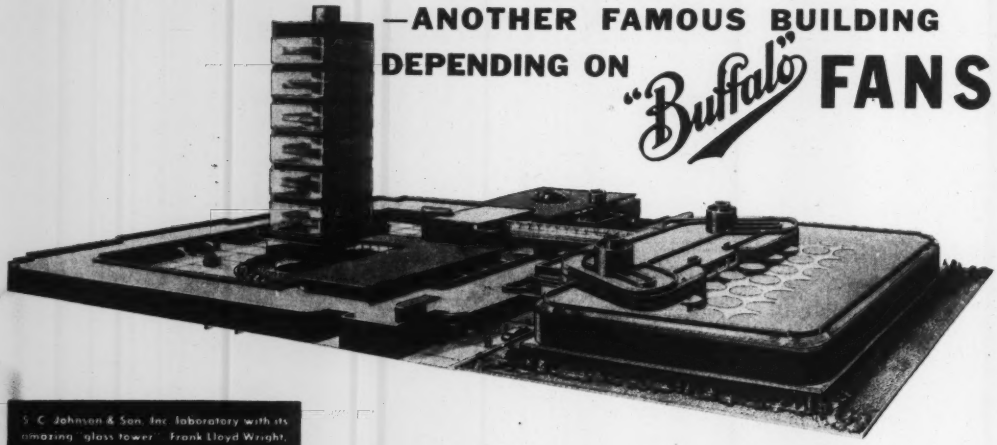
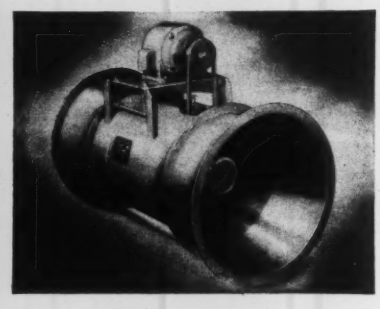


S. C. Johnson & Son, Inc. laboratory with its amazing "glass tower." Frank Lloyd Wright, Architect. Samuel R. Lewis, Consulting Engr. Fans by Buffalo Forge Company

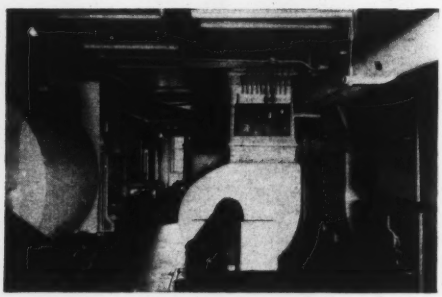
15 stories with glass and brick walls, the entire structure suspended by means of a concrete "core" running down through the center—the Johnson Wax Research Tower is one of the structural marvels of mid-century! Designed in behalf ot the American Housewife, the tower enjoys conditioned, dust-free air at all times. "Buffalo" fans supply the air.

"Buffalo" Fans are putting air to good use in every type of plant—improving product and process control—promoting health and safety—stepping up worker productiveness—increasing profits. And they are doing it efficiently.

Write us about your job for air. There's a "Buffalo" Fan or Air Conditioning unit to handle it to your satisfaction!



"Buffalo" Axial Flow Fans are popular both for light-duty ventilation and air conditioning work.



"Buffalo" LL Fans are widely used to supply air for air conditioning units, like these insulated fans.

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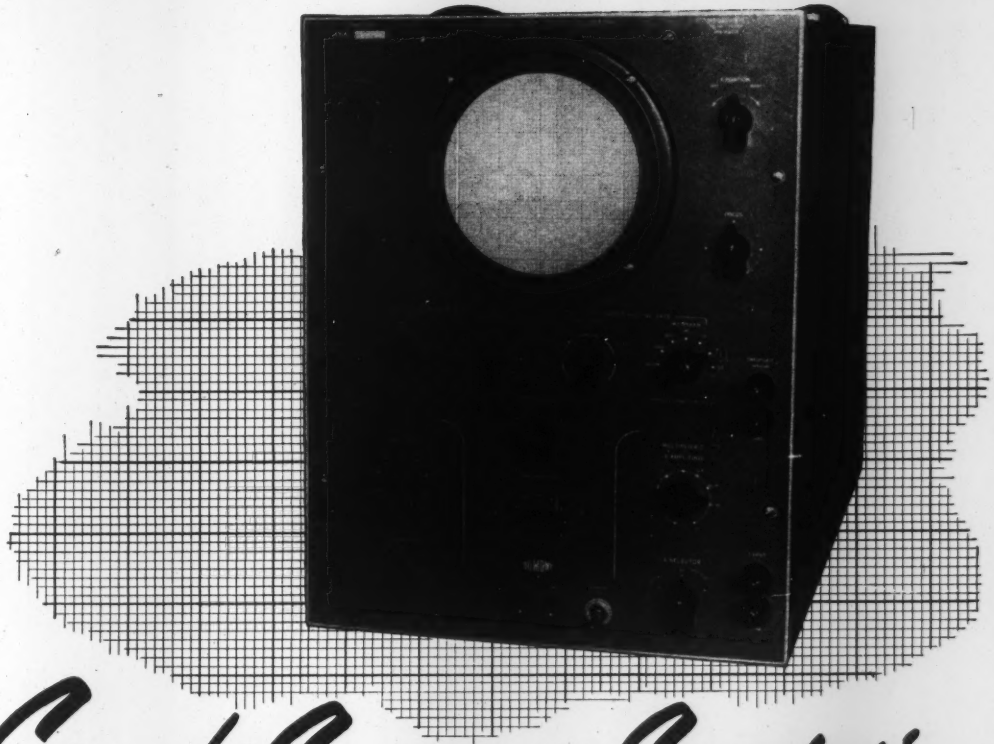

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by outperforming its own specifications...

Read the specifications of the Type 303 and you'll call it a 10-megacycle, quantitative instrument: operate the Type 303 and you'll realize you've sold it short. You'll find performance beyond the exacting limits of its specifications!

An exceptionally fine, medium-priced cathode-ray oscillograph, the Type 303 employs the new Type 5YP- Cathode-ray Tube. High sensitivity and an unusually wide range of sweep speeds make the Type 303 especially well suited for the study of high-frequency phenomena.

Using the equivalent of five inches of undistorted deflection on the Y axis, and six times full-screen expansion on the X axis, qualitative analyses can be highly detailed with the Type 303. Time and amplitude calibration add quantitative precision to this analysis, making the performance of the Type 303 unrivaled in the medium-price field.

Specifications

CATHODE-RAY TUBE — Type 5YP-

Y AXIS:

Sensitivity — 0.1 peak-to-peak volt per inch (down 30% at 10 cycles per second and 10 mc.) down 50% at 15 mc.
Pulse Rise Time — 0.03 microsecond.
Available Undistorted Deflection — 5" for symetrical signals and 2½" for unidirectional signals.
Signal Delay — Sufficient to allow for sweep-starting time.

X AXIS:

Sensitivity — 0.35 peak-to-peak volt/in. (flat to d-c down 30% at 500 kc).
Available Undistorted Deflection — 5"

SWEEP SPEEDS — up to 6" /μsec. obtained by expansion.

SWEEP DURATION — Continuously variable from 0.1 sec. to 2 μsecs. Driven or Recurrent operation.

VOLTAGE CALIBRATION — Square wave with peak-to-peak amplitudes of 0.1, 1, 10, and 100 volts. Accuracy ± 3%.

TIME CALIBRATION — Pulsed oscillations corresponding to time intervals of 100, 10, 1, or 0.1 μsec. Accuracy better than ± 3%.

INTENSITY MODULATION — 15 volts peak will blank the beam.

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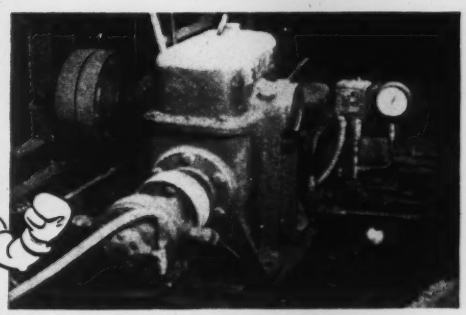
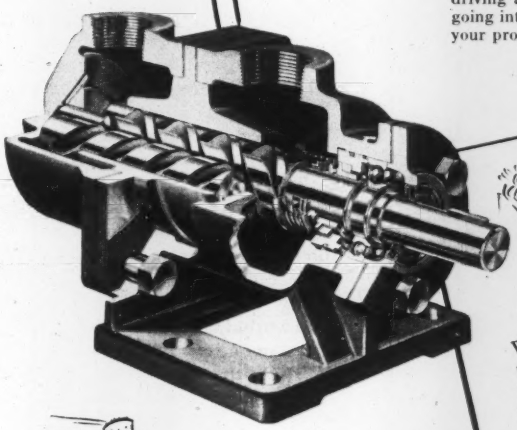


Tough service?... You bet!

0 to 800 rpm in 8/10 Second . . . 26 Times per Minute. And this De Laval speed reducer takes it and likes it. This particular unit is driving a conveyor belt that automatically feeds and measures billets going into a shear. If you are rough on reducers in your plant, tell your problems to one of our power transmission engineers.



What do you want to pump?

Molasses, Glue, Lard, Soya Oil, Film Dope, Corn Syrup, Vegetable Oil, Paste, Fuel Oil, Shortening, Resin, Varnish, Linseed Oil, Viscose Rayon, Liquid Latex . . .

We frankly don't know all the other products that an IMO can pump, but if you want a better way to transfer fluids like these from one place to another, chances are an IMO can do the job for you. The IMO is a screw-type rotary pump. Its axial flow design permits liquids to be pumped close to the axis of the rotor. This means low liquid velocity through the pump and quiet pulsation-free flow. Capacities range to 1000 gpm at 500 psi and 150 gpm at 1500 psi.

There's a new idea here!

We've simplified the already simple centrifugal pump! Our new GS pump is designed so that every working part . . . every part subject to wear, is contained in one easily replaced unit rotor assembly. Through our Service and Exchange Plan new rotor assemblies are available for immediate shipment from conveniently located stocks throughout the country.

This means good service, and if maintenance ever does become necessary, all you have to do is remove the cover and end plate bolts, lift out the old rotor and drop a new one in place. *It's that easy!* Capacities to 400 gpm — heads to 230 feet.

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CENTRIFUGAL PUMPS • WORM GEAR SPEED REDUCERS • IMO OIL PUMPS

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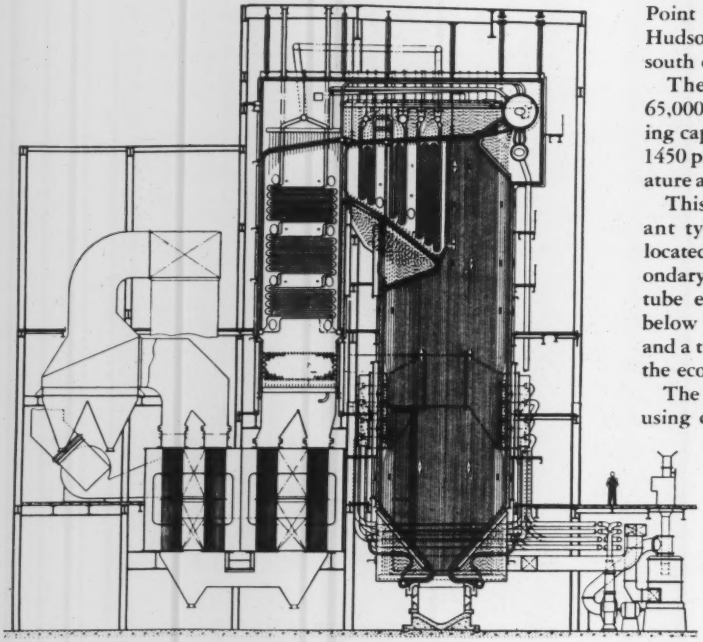

The C-E Unit shown here is in process of fabrication for the Danskammer Point Steam Station of the Central Hudson Gas & Electric Corporation, south of Newburgh, N. Y.

The Unit is designed to serve 65,000 kilowatts of electric generating capacity at a throttle pressure of 1450 psi, with primary steam temperature at 1000 F reheated to 1000 F.

This steam generator is of the radiant type with a reheater section located between the primary and secondary superheater surface. A finned tube economizer section is located below the rear superheater section, and a tubular type air heater follows the economizer.

The furnace is fully water cooled, using closely spaced plain tubes. It is of the basket-bottom type, discharging to a sluicing ash hopper.

Pulverized coal firing is employed, using bowl mills and tilting tangential burners. Arrangements are made to burn oil when and as desired. B-441

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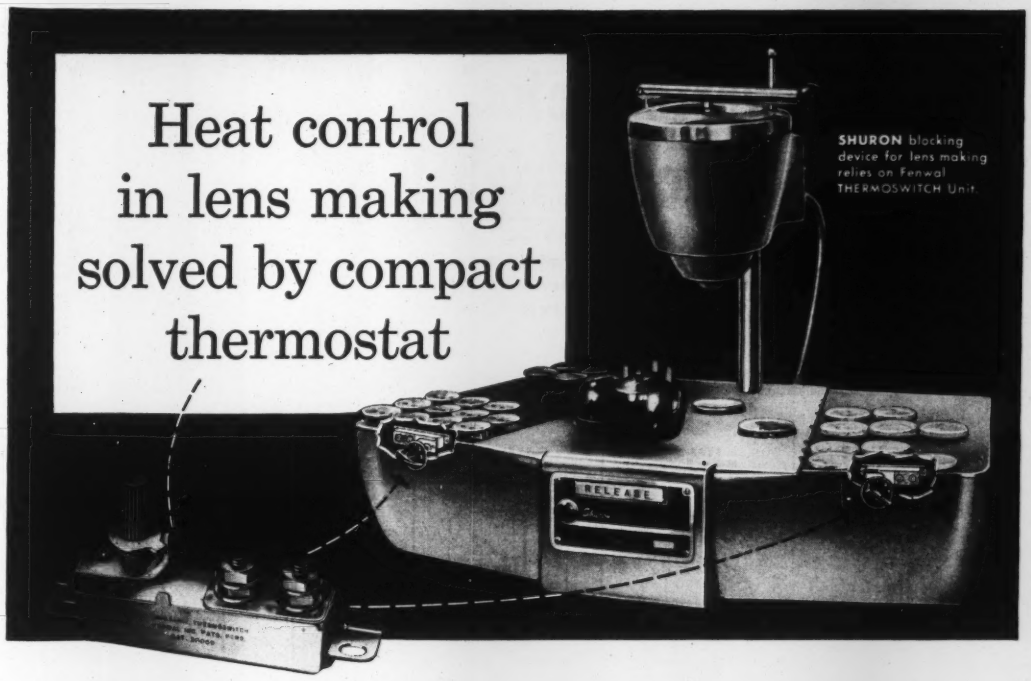
ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

Heat control in lens making solved by compact thermostat



SHURON blocking device for lens making relies on Fenwal THERMOSWITCH Unit.

When the Shuron Optical Company designed a new machine for speeding up the lens-blocking operation, the problem of heat control proved a vital factor. Both lenses and blocks had to be warmed on hot plates at pre-determined temperatures that had to be uniform.

Shuron needed a very compact thermostat that could be depended upon for long-lasting, reliable, accurate performance. Cost was also important. After experimenting, the Fenwal Appliance THERMOSWITCH Unit was selected as best able to meet all requirements. It was approved as a standard specification on the Shuron device, successfully performs its function with regular efficiency.

The use of the Fenwal Appliance THERMOSWITCH Unit by the Shuron Optical Company is but one of many ways in which this unique, minimal size, low-cost thermostat is benefiting industry. Its activating control element is the single-metal stainless steel case that expands or contracts *instantaneously* with temperature changes, making or breaking the totally enclosed electrical contacts.

You, too, can benefit from Fenwal performance. Wherever heat is a factor, you can rely on THERMOSWITCH Units for effective control. For further details, mail coupon below.

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APPLIANCE-TYPE

THERMOSWITCH®

The Precision, Multi-Purpose, Thermostat Control

SENSITIVE...*but only to heat*

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- ☐ Humidity Control or Detection
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- ☐ Vapor Control
- ☐ Timing (thermal)
- ☐ Radiant Heat Control
- ☐ Pressure Control (by controlling vapor temperature)

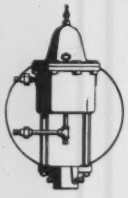
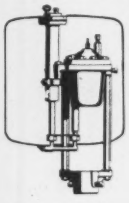
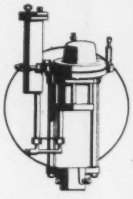
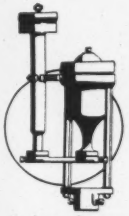
OTHER (Please fill in your special requirements).....

.....

.....

What's worth metering is worth metering right!

. . . and Foxboro offers the *right* meter for any metering problem. See the varied types below.

TYPES 1 & 2 Meter Body	TYPE 9 Meter Body	TYPE 17 Meter Body	TYPE 8 Meter Body	TYPE 6 Meter Body
				
light weight & low cost for indicators & portable recorders.	for differential ranges as low as 1" H_2O especially for low pressure gas and air service	Unequalled quality meter for general industrial service	longest float travel, greatest power, highest accuracy meter ever built	leakproof measurement at really *high* pressures without compromise in accuracy

a flow meter type for every need

From its complete line of flow meters, Foxboro can offer the *best* type — in the proper range and static pressure rating — for virtually any metering problem. They are available as indicators, recorders, controllers, and transmitters . . . known throughout industry for their accuracy, dependability, and economy.

The widest selection of flow instruments is only one of many factors responsible for Foxboro's acknowledged leadership in flow metering. See how this factor—together with many superior, exclusive design features — give you the most value for your money in flow metering. Write for Bulletin 351-2. **The Foxboro Company, 1824 Neponset Ave., Foxboro, Mass., U. S. A.**

Specifications of Foxboro Meter Types Illustrated

TYPE	MATERIAL	MAX. W. P.	RANGES
2	Forged Steel	1000	100"–200"
9	Cast Iron	150	1" –10"
17	Forged Steel	1800	10"–400"
8	Forged Steel	1500	50"–400"
6	Forged Steel	3500	100"–200"

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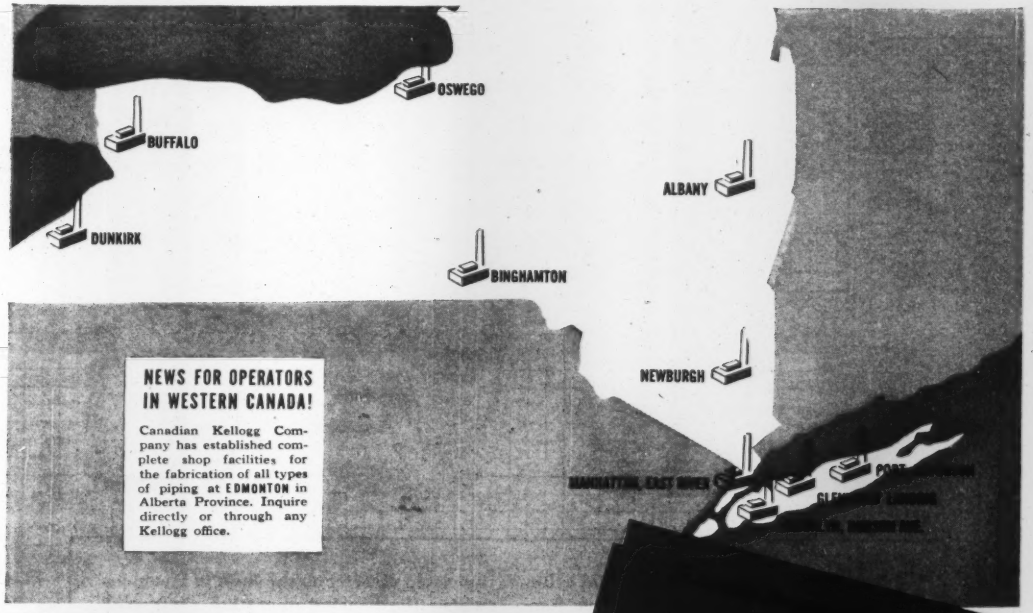
Note: Over 1,250,000 kws for New York State alone!

...within a very short space of time, we have contracted to fabricate the major power piping for over 1,250,000 kws. of additional steam power capacity for New York State alone. Most of these orders include job-site installations as well. All piping is for modern high-pressure, high-temperature systems — predominantly of the reheat type — with operating temperatures of 1000°F. or higher. When completed these new power installations will expand the state's total steam-generated capacity by well over 20%.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Canadian Kellogg Company has established complete shop facilities for the fabrication of all types of piping at EDMONTON in Alberta Province. Inquire directly or through any Kellogg office.

Special studies of unusual problems such as graphitization to assure long life and low maintenance.

Metallurgical research by recognized specialists who have made major contributions in this field.

M. W. KELLOGG
50th ANNIVERSARY
1901 - 1951

Exclusive Equipment for accurately analyzing stresses in piping and providing unique data for critical installations.

Complete facilities for the fabrication of steel products from simple forgings to specially cast bi-metallic devices.

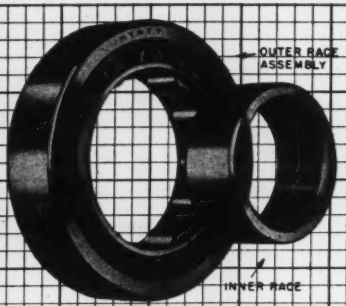
Top welding performance in shops and in the field by welders accustomed to working under X-Ray checks.

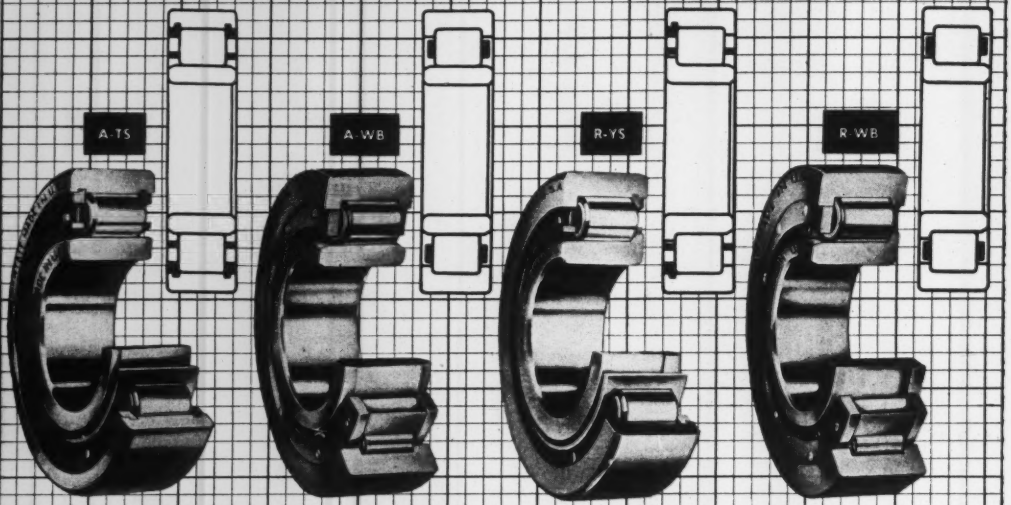
Quality control, devised by metallurgical experts, embracing forming, heat treating and non-destructive testing.

Pressure Vessels
Vacuum Vessels
Fractionating Columns
Drums and Shells
Heat Exchangers
Process Piping
Bends and Headers
Giant One-Piece Bends
Forged and Welded Fittings
Radial Brick Chimneys

The M. W. Kellogg Company, (A Subsidiary of Pullman Incorporated) — Offices in New York, Jersey City, Buffalo, Los Angeles, Tulsa, Houston, Toronto, London and Paris.

For Separable Inner Race Bearings-- HYATT HY-LOADS





IN the Hyatt Hy-Load line of solid cylindrical roller bearings there are four types which are made with separable inner races. These inner races are freely interchangeable with any roller assembly of the same number thus permitting non-selective fitting after pre-assembling the two bearing parts in separable machine elements. This Hyatt feature speeds final assembly, permits more efficient production planning and layout, and often leads to improvements in product design.

When a shaft of larger diameter is needed for greater rigidity or a bearing of smaller size is desired, the separable inner race can be omitted and the rollers operated directly on the shaft in instances where the bearing operating surface of the shaft can be of suitable hardness and finish.

In addition to the Hy-Loads with separable inner races there are separable outer race and non-separable types each of which are made in a wide range of sizes.

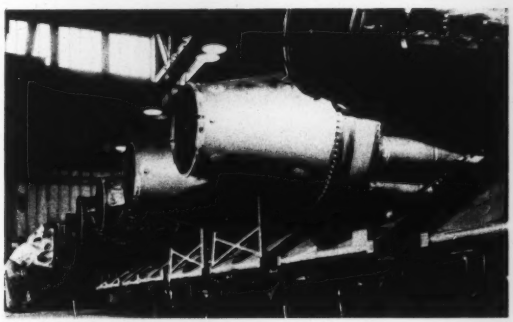
Full information about all Hyatt Hy-Load Roller Bearings is contained in Catalog 547 . . . a complete engineering guide to radial bearing selection and use. Write for your copy today. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS

FRED A. HOFMANN, production vice president of the Elastic Stop Nut Corporation of America, says, "We're back on a full 2-shift production schedule, and practically every one of the 62 Tri-Clad motors we've installed since 1941 in our plant at Union, N. J., is going night and day. Sure, we make a lot of steel products, but for a general-purpose motor, we don't think you can beat cast iron. After the pounding we've given our Tri-Clad motors for the past 10 years, we're stronger than ever for Tri-Clads."

ELASTIC STOP NUT CORPORATION:

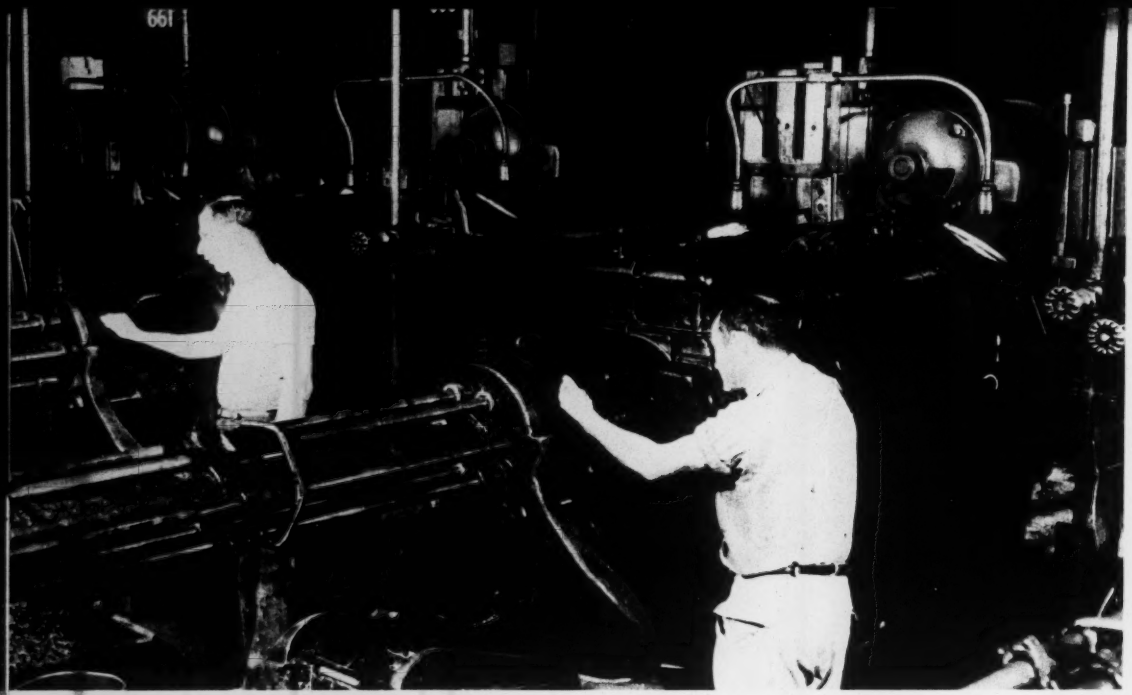
"We're stronger than ever for Tri-Clad triple protection!"



TRI-CLAD MOTORS drive machines that produce ESNA fasteners for use on jet aircraft engines—the engines that power our modern military planes. Each of the jet engines above uses a large number of these special stainless-steel high-temperature nuts, designed to hold under the extreme heat and other severe conditions of jet-engine operation. Moreover, these nuts must be re-usable without seizing or galling the finish. ESNA counts on the reliability of their Tri-Clads to help turn out thousands of these fasteners every day.

VIRILE VETERAN. This 10-hp Tri-Clad motor has been driving an Acme Gridley multiple spindle bar machine for nearly 10 years. It's still going strong, another reason why, after 10 years, ESNA thinks Tri-Clad is still their best motor buy! And today's Tri-Clad motor, all-industry favorite, is better than ever!

GENERAL ELECTRIC



4 STEPS—AND NO HANDS! Backbone of the ESNA production line, the Acme Gridley automatic bar machine (3 shown above) ejects a finished nut blank every 4½ seconds. The operator simply keeps the six spindles supplied with bar stock. The machine feeds stock, machines the nut profile, drills 2 holes and cuts off to accurate lengths. The load on the 10-hp drive motor is heavy and constant—but Tri-Clad, with its bearings completely enclosed in cast-iron housings, can take it! Maintenance department can't recall a single Tri-Clad bearing ever having to be replaced. Moreover, if they need it, the motors are easily greased while running.

GE

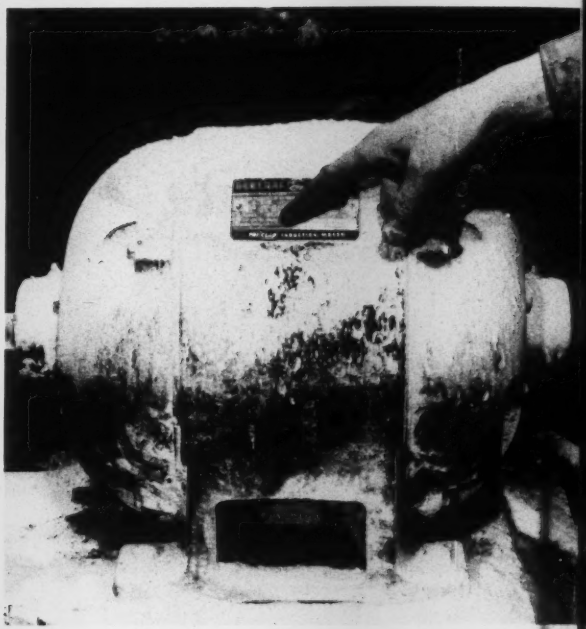
TRI CLAD MOTORS

REG U.S. PAT. OFF.

Help Keep ESNA Production Up!

PRODUCTION PUSHER General plant foreman Karl Kjellburg has the job of meeting "impossible" defense program manufacturing schedules. He's counting heavily on automatically fed machines like the Tri-Clad driven V. & O. press on his left; says, "This press inserts over 200 elastic fibre locking collars a minute in a $\frac{3}{8}$" fastener. Driving it is a big job for a motor. Our Tri-Clads gave us no trouble during the war. We're counting on them again!"

TROUBLE SHOOTER TESTIFIES Ed Conk, ESNA's maintenance chief, must furnish reliable power wherever it's needed in the plant. He's got some definite ideas about electric motors; says, "We like a motor you can regrease easily *if you have to.* So far, we've had to regrease very few of our Tri-Clad motors. And those were either on hot spots or on particularly tough jobs. The point is—we *could* readily have regreased them all if it was necessary."



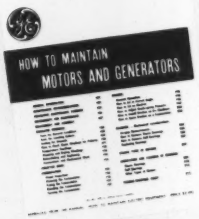
TOUGHEST... on the inside Extra protection against electrical breakdown is built into every Tri-Clad motor. Formex* wire windings, one-piece cast-aluminum rotor, double-end ventilation—these are features that prolong a general purpose motor's useful life.

TOUGHEST... on the outside Teeth rattling blows, dripping liquids, corrosive fumes—they're all in a day's work for Tri-Clad cast-iron construction. You get a rigid structure, too—one that won't twist out of line when you're bolting it down.

TOUGHEST... at the bearings A Tri-Clad motor will run safely without relubrication for as long as any general purpose motor you can buy. But, if the application does make relubrication a "must", you can grease your Tri-Clad without halting production.

** Reg. U.S. Pat. Off.*

How to Keep Your Motors in Shape for the Job Ahead!



TIMELY READING With every electric motor needed on the line, once again it's time to be a crank about motor care. That's why every motor user needs this General Electric manual. Tells how to spot motor and generator trouble before it happens, how to prevent serious breakdown, how to conduct a regular motor maintenance program. Order a copy for your maintenance department today! Use the coupon!

General Electric Company
Section 732-8
Schenectady 5, New York

Please send me my free copy of "How To Maintain Motors and Generators" (GET-1202)

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City_____ **State**_____

GENERAL ELECTRIC

You'll find some worthwhile information on motor control on the next page ➡

Herman F. Zoll, Purchasing Agent and Arthur B. Sullivan, Chief Engineer of John R. Evans & Co. inspect the G-E motor starter that is giving motors throughout their plant the reliable control and protection needed to keep output up, rejects down.

"...NO SHUTDOWNS DUE TO STARTER FAILURE!"

Here's a tip on real motor-starter dependability from a leather-processing plant executive

As chief engineer of a leather-processing plant, it's Mr. Arthur B. Sullivan's job to keep electrical equipment throughout the plant running smoothly. So it's a safe bet he knows what he's talking about when it comes to motor-starter dependability.

Says Mr. Sullivan: "When a motor drive won't start because its motor starter fails, we're tied up until it's fixed. We lose output and, if it's a continuous processing line our rejects may be high.

"Because of this, we've had to compare starter against starter. We haven't found one that beats this G-E starter. Since installing it, we've had practically no shutdowns due to faulty starting. What's more, this G-E starter is easier to install and service. We're sold on it!"

Martin Kelly, Evans Co. Plant Electrician, removes arc hood on G-E motor starter that isolates and protects each contact in its own chamber.

MAKE SURE YOUR PLANT ELECTRICIAN KNOWS ABOUT THESE G-E STARTER FEATURES:

For Longer Life

Fine silver contacts, "Strongbox" Magnet Coil, "molded-in" coil lubricant.

For Easier Maintenance

A screwdriver is the only tool needed for servicing. All terminals are "up front".

For Greater Flexibility

Contacts that are easily changed from normally open to normally closed.

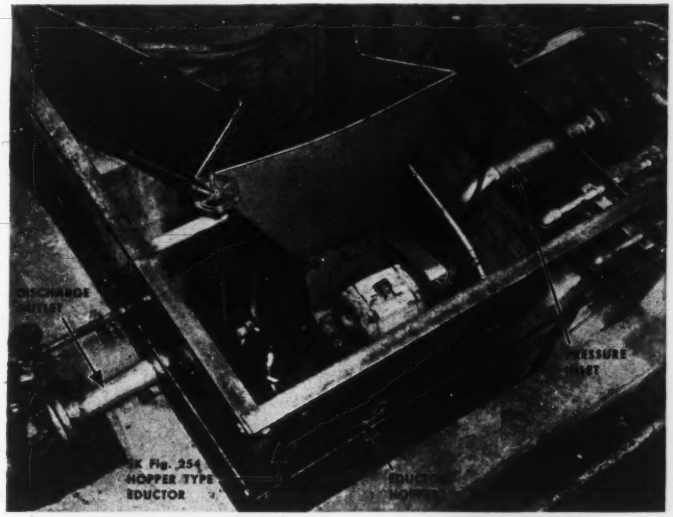
For details on the full line of G-E magnetic motor starters, write for Bulletin GEA-5153. Manual starters for infrequent starting operations are described in Bulletin GEA-1522. For pricing and shipping data, phone or write your G-E representative or authorized G-E distributor. *Section A730-21, Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

730-21

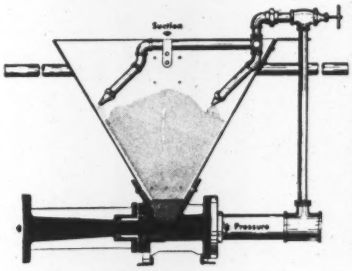
SK News

Esso Standard Oil Co. Uses SK Eductor To Outmode Hand Mixing



In the manufacture of certain chemicals made from petroleum derivatives, the Bayway Refinery of Esso Standard Oil Company at Linden, N. J., found it necessary to add and mix large quantities of granular dry solids in a liquid stream.

Prior to installation of an SK Fig. 254 Hopper Type Eductor, illustrated, this mixing was done by hand. Economies of the new method were immediate and gratifying: labor for mixing was eliminated; mixing time was reduced; efficient mixing was obtained; and area appearance was improved.



The 3" Eductor, shown in the photo and in detail in the drawing, is located in a concrete pit. Liquid is pumped from a feed tank by means of a centrifugal pump through the eductor and back into the feed tank. During this liquid recirculation, granular dry solids are added to the stream until proper ratio is obtained, at which time the liquid is pumped from the feed tank directly into the storage tank, by-passing the eductor.

The Bayway Refinery has mounted a rotary crushing machine atop the eductor hopper for the purpose of crushing large particles into sizes suitable for feeding into the hopper of the eductor and from there into the eductor chamber. The installation handles 72 lbs. per minute of solids with 100 gpm of liquid at 50 psi gauge maintaining a 20 ft. head at discharge.

For details on all types and sizes of SK Eductors, request Bulletin 2-M.

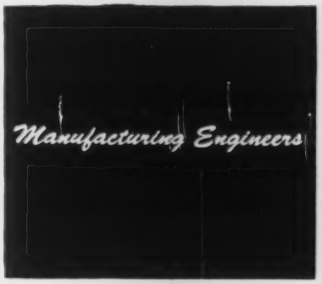
HAVEG SPARGER NOZZLES RESIST CHEMICALS, GIVE EVEN TANK TEMPERATURE

Recent installations in industrial plants show that definite savings can be realized by using SK Haveg Sparger Nozzles in the tank heating of certain chemicals and acids.

Molded in one piece from Haveg 41 or 60 with $1/2$" connection for threading in Haveg threaded pipe, these nozzles can handle any temperature up to 265° F.—the corresponding steam pressure in such case being 25 psi.

In addition to cutting replacement costs resulting from corrosion and excessive wear, SK Haveg Sparger Nozzles offer quiet operation, more intimate mixing, and maintain more even tank temperature. Steam, issuing from the Haveg Sparger Pipe through the tip of the steam nozzle at high velocity, entrains tank liquid through the open areas on each side of the nozzle. The steam and tank liquid enter the nozzle chamber where they are thoroughly mixed and discharged with sufficient force to cause constant agitation and uniform heating within the tank.

SK Haveg Sparger Nozzles are available from stock. Request details.



Farval lubricates press for "Big Inch" line pipe

FARVAL—*Studies in Centralized Lubrication* No. 119

Three Farval centralized systems lubricate this 2000-ton hydraulic press. It forms steel plates, ¼" to ½" thick, into U-shape as a step in making electric-weld pipe.

● Since April, 1950, a new type of hydraulic press has been U-shaping forty-foot lengths of half-inch steel plate in the process of forming electric weld oil field pipe. Sizes produced range from 26 to 36 inches in diameter—for bigger "Big Inch" lines.

Lubrication is no problem on this press. It is served by three manually operated Farval systems —one of these lubricates 32 points on the gibs, while the other two lubricate 114 bearings on the dies.

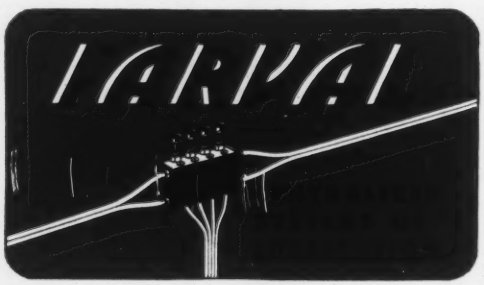
With Farval on the job, there has been no need for extra men as oilers, no waste of lubricant, and even more important, no down time either to oil hard-to-get-at points or to replace worn-out bearings.

In this and in hundreds of other plants, on presses and other industrial machinery, Farval Centralized Lubrication has paid for itself in savings—savings in oiling labor, lubricants, bearing expense and production time.

Farval is the original Dualine system of centralized lubrication, proved practical in 20 years of service. The Farval valve has only two moving parts—is simple, sure and foolproof, without springs, ball-checks or pinhole ports to cause trouble. Through its full hydraulic operation, Farval unfailingly delivers grease or oil to each bearing—as much as you want, exactly measured —as often as desired. Indicators at every bearing show that each valve has functioned.

Write for Bulletin 25 for full details. The Farval Corporation, 3264 East 80th St., Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.



properties of and test data on

CELLULAR RUBBER

New Booklet Just Released

Send for your free copy of this up-to-date, authoritative work on the grades of, the chemical and physical properties of, and test data on cellular rubber. Lists A. S. T. M., Army, Navy and Air Force specifications, among others. The most complete reference work yet produced on this highly-adaptable product of widely diversified usage.

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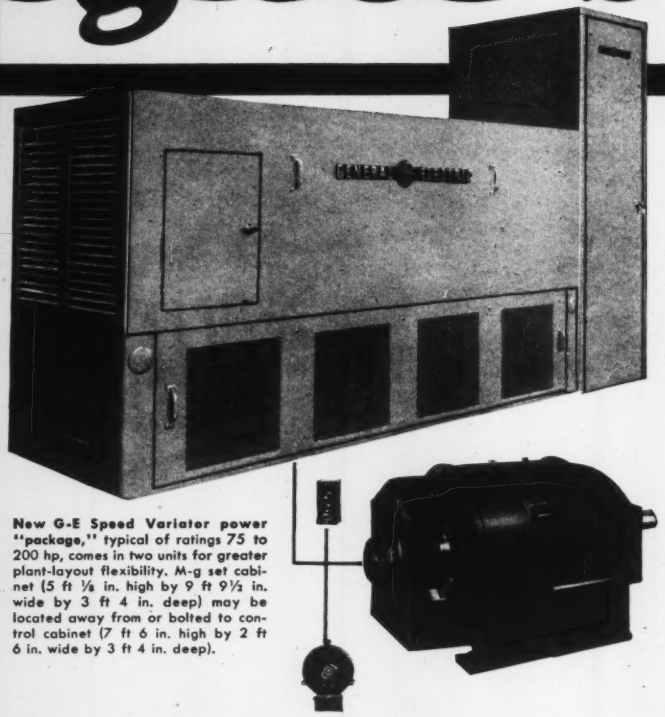
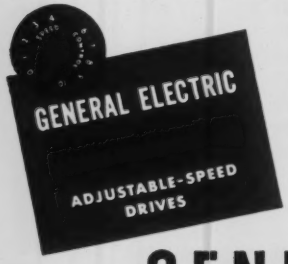
NOW up to 200 hp in one compact package!



New G-E Speed Variator power "package," typical of ratings 75 to 200 hp, comes in two units for greater plant-layout flexibility. M-g set cabinet (5 ft ⅛ in. high by 9 ft 9½ in. wide by 3 ft 4 in. deep) may be located away from or bolted to control cabinet (7 ft 6 in. high by 2 ft 6 in. wide by 3 ft 4 in. deep).

SPEED VARIATORS

All the advantages designers have appreciated in General Electric Speed Variators—packaged, pre-engineered adjustable-speed drives operating from a-c power systems—can now be obtained in units rated 75 to 200 hp. On punch presses, wire drawing machines, mill auxiliary drives, etc., they provide the same speed ranges up to 40:1 and beyond, good speed regulation, great operating flexibility, and minimum installation and maintenance cost.



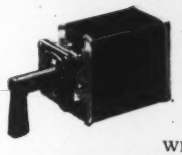
With adjustable-voltage control in whatever type is most suited to the need—straight magnetic, amplidyne, or electronic—this new drive requires no special foundations, includes all necessary protective features, and contains all wiring between components except to the remotely-mounted motor and operator's controls.

Best of all, standardized component design lets you specify only the features you need, permits prices comparable to other drives that require costly field assembly. For more information on these new larger-hp Speed Variators, check your nearest G-E Apparatus Sales Office. Bulletin GEA-5335 describes Speed Variators in 1–60 hp ratings.

GENERAL ELECTRIC

Digest

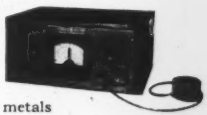
PRODUCT HIGHLIGHTS



VERSATILE SWITCH makes good 10,000 ways!

What's behind the success story of the General Electric Type SB-1 switch? Simply this: By varying its many *standard, interchangeable* cams, contacts, fingers and other parts, you can arrange for over 10,000 control and transfer combinations, use it for practically any control job on low-capacity circuits. For extra-heavy duty, there's the tougher Type SB-9, with the same features plus extra wear-resistance. Both types mount on ⅛- to 2-inch-thick panels, are rated up to 20 amperes at 600 volts a-c or d-c. See Bulletins GEA-4746 (SB-1) and GEA-4114 (SB-9).

METALS COMPARATOR cuts scrap losses economically!



With both ferrous and non-ferrous metals now in tight supply, you'll need the material savings a General Electric metals comparator can bring you. It provides an economical, non-destructive test of metal parts for composition, heat treatment, hardness, or plating thickness—decreases scrap losses due to mixed material or incorrect processing. Parts are quickly compared against a reference standard. Uses single-phase, 60-cycle, 110-volt supply. See Bulletin GEC-566.

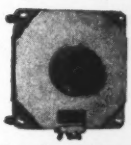
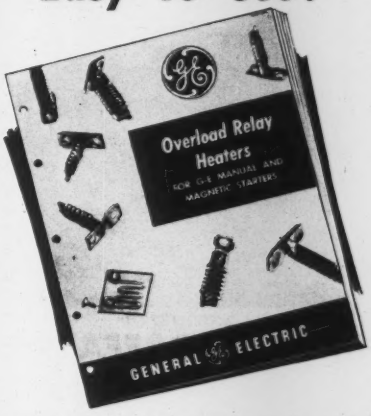


PLATE-TYPE RHEOSTAT gives accurate speed control!

Specify these General Electric plate-type field rheostats for mounting on a machine tool, switchboard, or control or operator's panel, and you've provided for speed control of d-c motors, or voltage control of generators and exciters. The 6-, 9-, and 12-inch standard sizes contain 27, 52, and 70 resistance steps for accurate adjustment. Adjustable stops at each end of travel save time, assure uniform operation, are easily reset for added flexibility. See Bulletin GEC-487.

New! Complete! Easy to use!



LISTS RELAY-HEATER RATINGS FOR G-E MOTOR STARTERS

Just out is this handy guide to the selection of overload relay heaters for most types and sizes of General Electric manual and magnetic starters. In one convenient 16-page reference booklet, it concentrates data from many sources, makes it easier and faster for you to match heaters to motors. Check Bulletin GEC-127B in the coupon below.

General Electric Company, Sec. F668-88
Schenectady 5, New York

Please send me the following bulletins:

√ for reference purposes
X in connection with immediate projects

- ☐ GEA-4114 Type SB-9 switch
- ☐ GEA-4746 Type SB-1 switch
- ☐ GEA-5335 1-60 hp speed variator
- ☐ GEC-127 Relay-heater catalog
- ☐ GEC-487 Plate-type field rheostat
- ☐ GEC-566 Metals comparator

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From interpretation to installation . . .

GRINNELL PREFABRICATED PIPING

assures greater customer satisfaction through its five-point program of

Quality Control

The bending operation illustrated above is an example of Grinnell QUALITY CONTROL *in action* . . .

The tubing shown is made from a chromium alloy steel forging, turned and bored. Outside diameter is 14¾ inches; wall thickness 2⅜ inches. Temperatures of the tubing within the bending furnace were maintained and controlled within 20°F of specified temperatures. Bending was done with such skill and rapidity as to permit a temperature drop of only 100°F at the inside surface of the tubing. Maximum thinning was only .06 inch.

Designed for a central station power plant to accommodate 1500 PSI and 1050°F, this is typical of Grinnell's engineering knowledge which assures prefabricated piping of the right kind — for all types of installations no matter how complex.

QUALITY CONTROL is the result of Grinnell's 100 years of practical experience in the field of piping. Delivery of prefabricated piping subassemblies to exacting engineering requirements which meet all governing code requirements is assured by Grinnell Quality Control, which includes:

- Interpretative engineering
- Metallurgical research
- Specialized facilities
- Skilled personnel
- Rigid inspection

ECONOMY of specifying Grinnell prefabricating piping results from:

- One source for design, interpretation and fabrication
- Coordination of shop production under ideal conditions
- Elimination of waste by paying only for finished material delivered
- Reduction in field erection time

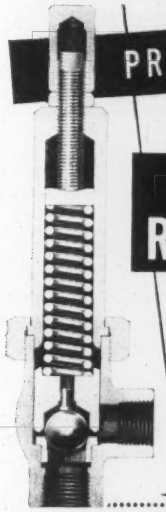
Write for the booklet, Grinnell Prefabricated Piping.

GRINNELL

WHENEVER PIPING IS INVOLVED

GRINNELL COMPANY, INC., Providence, R. I. Warehouses: Atlanta • Billings • Buffalo • Charlotte • Chicago Cleveland • Cranston • Fresno • Kansas City • Houston • Long Beach • Los Angeles • Milwaukee • Minneapolis • New York Oakland • Philadelphia • Pocatello • Sacramento • St. Louis • St. Paul • San Francisco • Seattle • Spokane

Specify these Edward Steel Valves . . . from the Line that Gives You the Better Designs



PROTECT EQUIPMENT

against abnormal pressure increases with

Edward RELIEF VALVES

Edward relief valves protect equipment against sudden and unusual pressure increases in piping systems. Foolproof design and accurate spring action make them absolutely dependable. One low cost valve can save much expensive equipment.

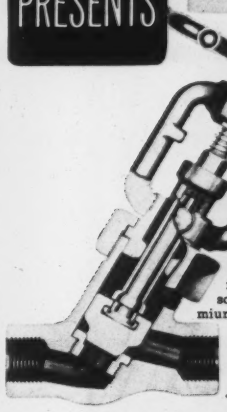
Used extensively in power, chemical, process, petroleum, hydraulic, marine, and general industrial service, they are particularly suited for relieving pressure in pump lines, drums, heat exchangers, and unfired pressure vessels handling water, steam, oil, or vapor.

They need no packing, maintenance is negligible, and the fine pitch threads of the adjusting screw allow close regulation of pressure setting.

NEW BULLETIN Write for new free bulletin No. 711 containing latest design details, dimensions, weights, and installation information.

Edward PRESENTS

New ALL-PURPOSE STEEL VALVES



A new all-purpose valve series, ideal for almost any service where small O. S. & Y. steel valves are used.

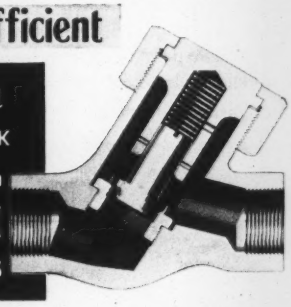
Drop forged steel for greatest strength . . . simplest packing arrangement . . . tight, easily accessible union or bolted bonnet joints . . . bronze yoke bushings . . . microscopically mated seats and disks . . . lock welded parts. Built in sizes ¼ to 2 in. inclusive, globe or angle, screwed or socket welding ends, carbon or chromium molybdenum steels, in 600 or 1500 lb sp classes. Stocks now available.

Bolted bonnet 1-¼ in. up 600 lb, 1 in. up 1500 lb. Union bonnet in smaller sizes.

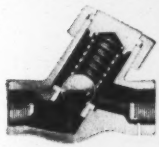
For full details, dimensions, illustrations write today for your free copy of . . . . **BULLETIN 501**

Quiet . . . Efficient

Edward NON-SHOCK Ball & Piston CHECK VALVES



Vibration, clatter, and damaging shock to piping are cut to a minimum with Edward forged steel ball and piston check valves. Cushioned closing action eliminates excessive vibration. Accurate guiding and spring loaded construction assure fast positive seating.

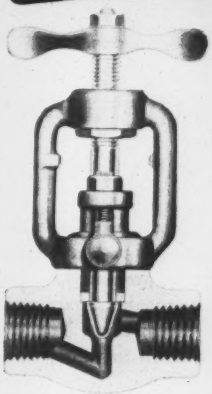


EValloy stainless steel seat and ball or piston give maximum trouble-free service.

Union or bolted bonnet in sizes ¼ in. to 2 in. inclusive in two pressure classes —600 lb at 850 F and 1500 lb at 850 F. For complete information, write for Catalog 104.

EDWARD BUILDS Globe and Angle Stop Valves • Integral Bonnet Univalves • Gate Valves • Non-Return Valves • Blow-Off Valves • Feed Line Stop-Check Valves • Intex (Integral Seat) Valves • Instrument Valves • Check Valves • Relief Valves • Hydraulic Valves • Gage Valves • Strainers • Special Designs

PRECISION REGULATION Edward Instrument Valves



New Edward Fig. 952 series instrument valves, so compact they fit limited spaces in such hook-ups as panel boards and manifolds, give precision regulation for meter, gage, regulator, by-pass and instrument lines of all types. Forged steel, globe or angle. Rated 6000 lb WOG, 1500 lb 850 F in carbon steel. Also in stainless steels with higher ratings.

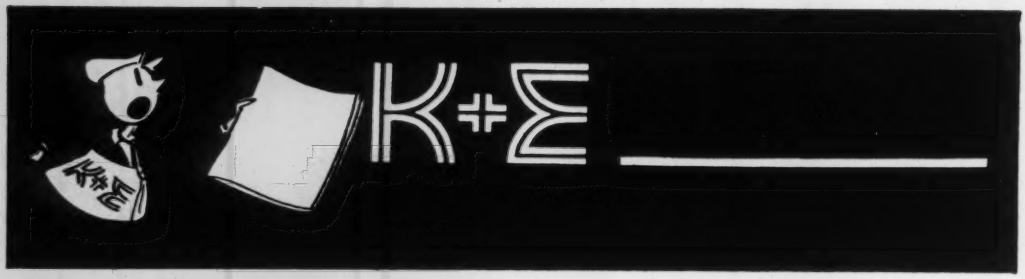
- No bonnet joint to leak.
- Swing bolted gland for easy packing.
- Needle point stem, fine pitch threads for accurate regulation.

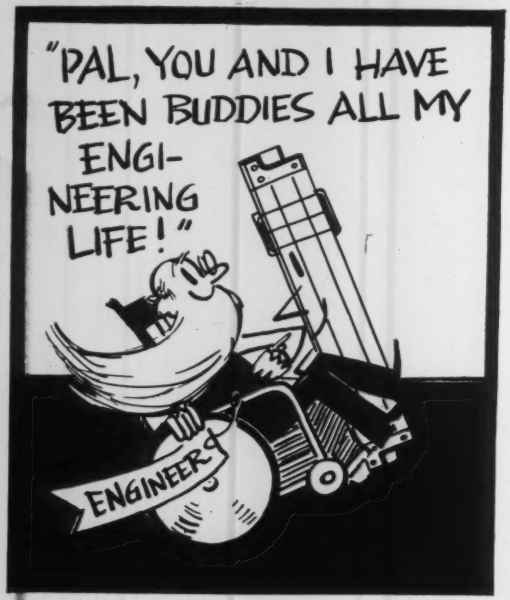
WRITE FOR NEW BULLETIN Bulletin 491, with full details, is yours for the asking.

Edward Valves, Inc.

SUBSIDIARY OF ROCKWELL MANUFACTURING CO.

EAST CHICAGO, INDIANA





Down through the years with a K&E Slide Rule

Although K&E Slide Rules are the oldest slide rules made in America, there are no whiskers on 'em—except cat's whiskers (I mean, symbolizing precision).

If you are an old engineer, you probably regard your K&E Slide Rule as a priceless Stradivarius. You are probably figuring on passing it down to your grandchildren.

If you are a beginner, the sooner you attach yourself to an immortal K&E rule, the better.

K&E Slide Rules have become accepted symbols of the engineering profession. If a photographer, illustrator or cartoonist wants to indicate that his hero is a top-flight engineer, he puts a K&E Slide Rule in his hand or in the immediate environment.

Ask anybody what he knows about Keuffel & Esser, and he first starts rhapsodizing about slide rules. Slide rules and K&E are synonymous.

And they're both almost as long lasting as the pyramids!

Keuffel & Esser have been around since 1867 and they completed their first batch of slide rules in 1891.

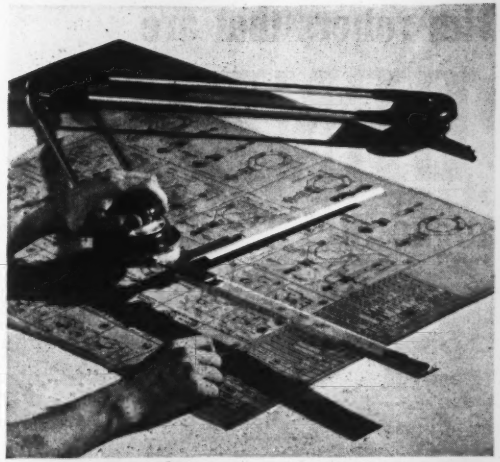
It is not uncommon to hear of a K&E rule which has been in service for over 50 years.

I used to think a slide rule was a slide rule—just as a yard stick is a yard stick—but there is a sensational variety of 'em in the K&E line—from the simple Mannheim to the more complicated brethren, such as the Log Log Duplex Trig and Decitrig and the Log Log Duplex Vector*.

Also, there are several sizes from the handy pocket rules, to the more common 10-inch, up to the 20-inch longfellows.

There's no point to hitching up for life with a "second best" slide rule when you can play a Keuffel & Esser.

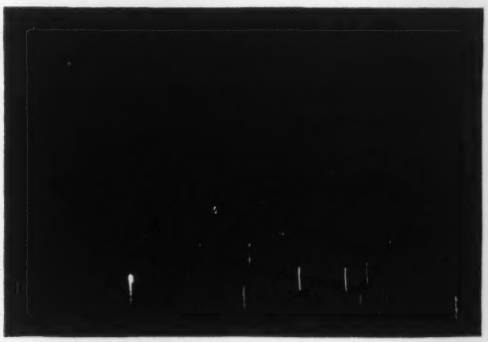
*Trade Marks ®



You wouldn't try to be Rachmaninoff without a piano, or a Kreisler without a fiddle. Well, who would want to be a draftsman without a K&E PARAGON† DRAFTING MACHINE?

This miracle machine makes you a veritable orchestra leader at your drawing board. It combines T-squares, triangles, protractors and scales, all in one unit, controlled entirely by one hand.

You can move a rule all over the board, and the rule stays parallel to its original position. You can draw all lines to exact length. The lightest touch rotates the scales to any angle desired.



Permanent accuracy is assured, because the open center arm construction makes it practically impossible to disturb the factory-set band tension.

†Trade Mark ®

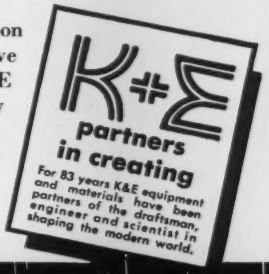
This K&E MOTORASER* makes old-fashioned hand erasing look horse and buggy. It reduces your erasing time to seconds.

Since it depends on speed rather than pressure, the MOTORASER does not wear holes in paper. It's as accurate as a pencil point, yet will clean large areas in a jiffy.

It's handy in the hand—a 3 inch palm full with a finger-tip switch—only 6 oz. Uses AC juice —60 cycle 110 volt AC—or DC with an inexpensive adapter. A sturdy little feller, too.

*Trade Mark

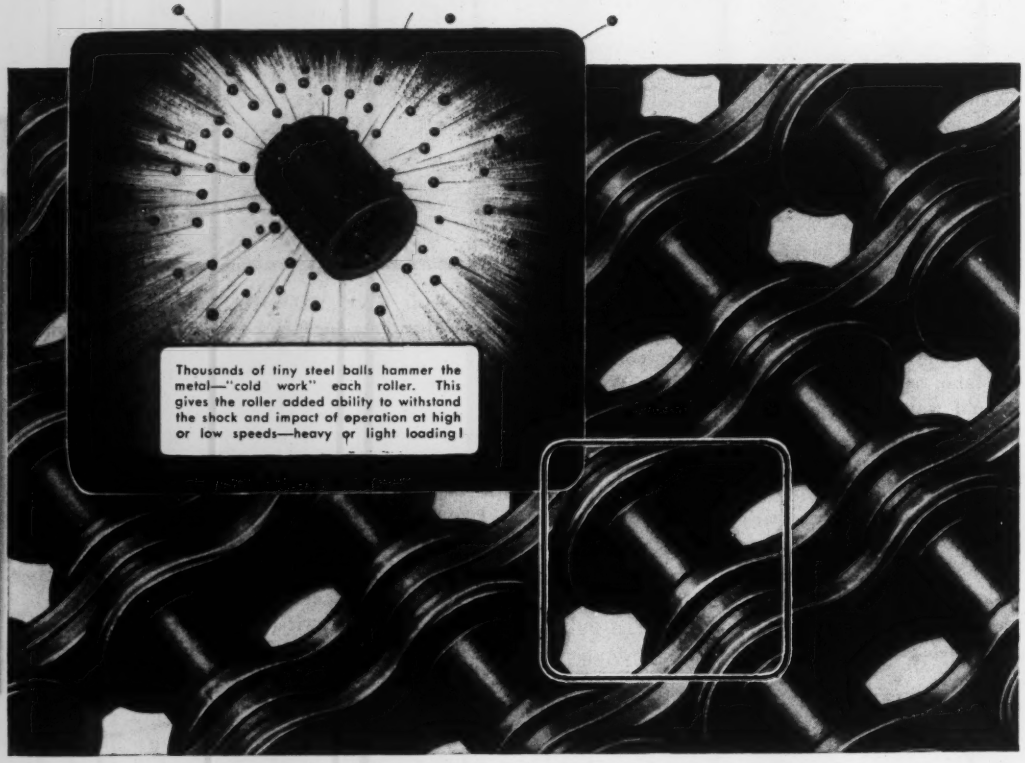
For further information about any of the above products, ask a K&E Distributor or any K&E Branch, or write to Keuffel & Esser Co., Hoboken, N. J.


K+E
partners in creating
For 83 years K&E equipment and materials have been partners of the draftsman, engineer and scientist in shaping the modern world.

Get the roller chain with rollers that are

SHOT PEENED

for EXTRA fatigue life!


Thousands of tiny steel balls hammer the metal—"cold work" each roller. This gives the roller added ability to withstand the shock and impact of operation at high or low speeds—heavy or light loading!

You get this added feature in every LINK-BELT Roller Chain

You get absolute uniformity, too. No highs. No lows. Just smooth, flowing dependable chains that pay off in wide flexibility—greater performance—longer life.

You see, LINK-BELT Roller Chains are made from carefully selected materials with controlled heat treatment to assure uniformity and absence of weak members, then—rollers are shot peened to give them the extra fatigue life needed for today's higher speeds and heavier loads.

Link-Belt Roller Chain is available in single or multiple widths, in $\frac{3}{8}$″ to 3″ pitch and double pitch. If you have a roller chain problem, see the LINK-BELT engineer nearest you.

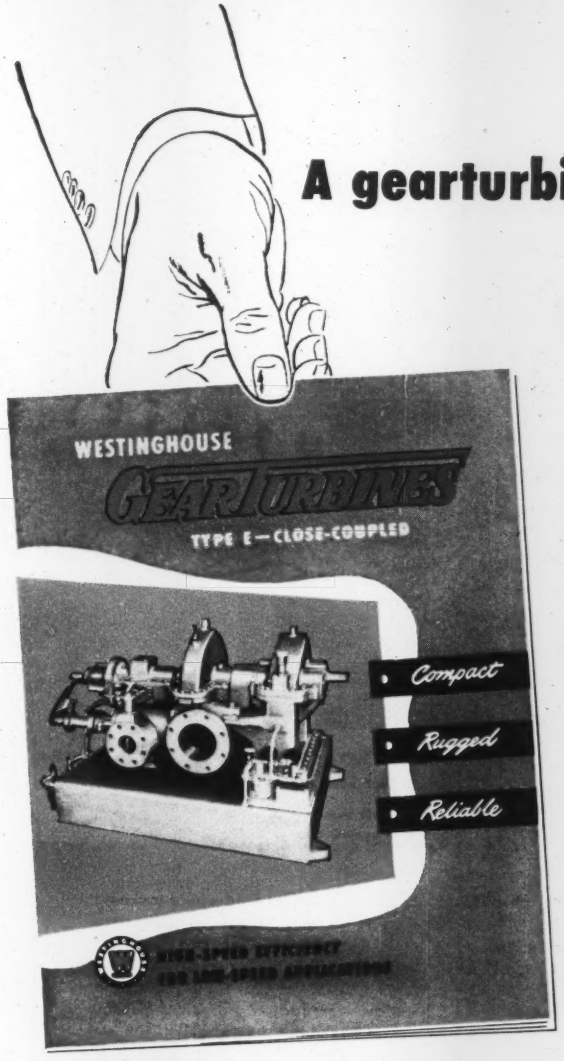
LINK-BELT

ROLLER CHAINS and SPROCKETS

LINK-BELT COMPANY. Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Johannesburg. Offices, Factory Branch Stores and Distributors in principal cities. 12,207

A gearturbine built to save...

Three ways



The Westinghouse Gearturbine costs less to buy . . . less to install . . . and less to maintain. Wrapped up in a single package is a compact, rugged and reliable speed-reduction unit solidly coupled to a Type E turbine. It's the ideal combination for ratings up to 500 hp and output speeds commonly found in single-ended applications.

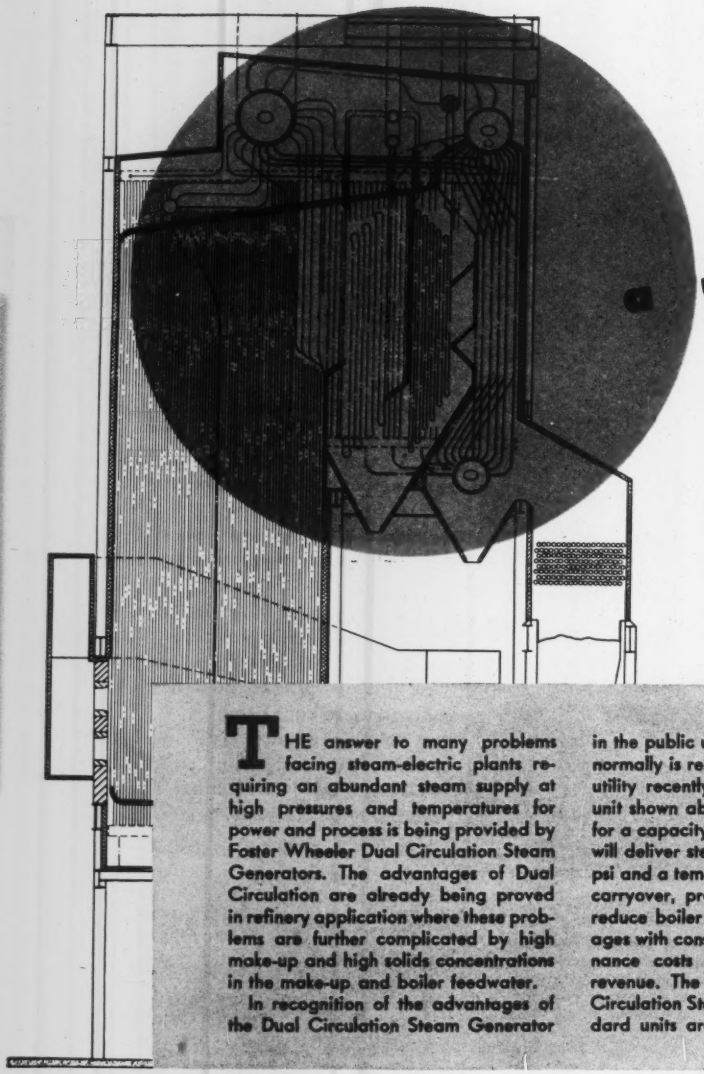
Here's economy made possible by a standardized design that cuts manufacturing costs . . . avoids costly specials . . . saves space . . . and simplifies maintenance. And you get the maximum flexibility possible . . . any combination of three turbine wheel sizes, three gears and three types of governor can be used according to your needs.

Other plus features are . . . solid coupling of turbine shaft to pinion shaft; single-helical gearing; forced circulation, filtered oil; and 3-point support for easy mounting and leveling.

J-50521

GET THE FULL STORY. A newly available booklet, B-4346, clearly explains the applications, refinements and advantages of Westinghouse Gearturbines. Ask your nearby Westinghouse representative for your copy, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

YOU CAN BE SURE.. IF IT'S
Westinghouse
TYPE E Turbines



a utility

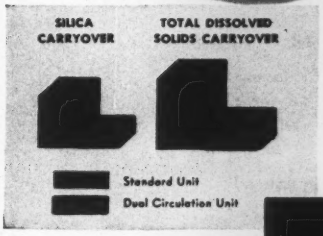
THE answer to many problems facing steam-electric plants requiring an abundant steam supply at high pressures and temperatures for power and process is being provided by Foster Wheeler Dual Circulation Steam Generators. The advantages of Dual Circulation are already being proved in refinery application where these problems are further complicated by high make-up and high solids concentrations in the make-up and boiler feedwater.

In recognition of the advantages of the Dual Circulation Steam Generator in the public utility field where make-up normally is relatively low, a midwestern utility recently ordered the three-drum unit shown above. This unit is designed for a capacity of 425,000 lb per hr and will deliver steam at a pressure of 1350 psi and a temperature of 955 F. The low carryover, previously unattainable, will reduce boiler and turbo-generator outages with consequent savings in maintenance costs and gains in operating revenue. The advantages of the Dual Circulation Steam Generator over standard units are illustrated at the right.

● *Write for a Copy of Bulletin B-50-11*

FOSTER WHEELER CORPORATION 165 BROADWAY NEW YORK 6.

specifies... DUAL-CIRCULATION

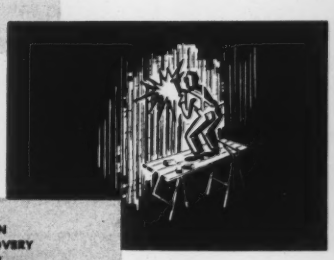


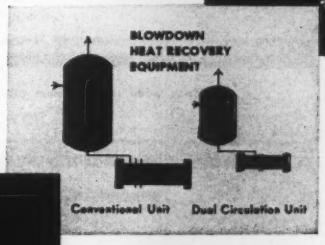
REDUCED CARRYOVER OF

a. Silica
b. Total Dissolved Solids

LOW CONCENTRATION IN HIGH DUTY FURNACE SECTION RESULTING IN

a. Minimum Tube Damage
b. Reduced Maintenance and Outage Time





IMPORTANT SUPPLEMENTARY ADVANTAGES IN CERTAIN APPLICATIONS

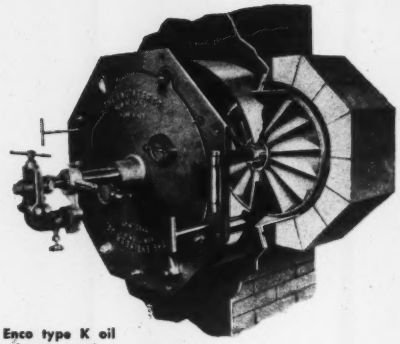
a. Reduced Blowdown With Resulting Reduction In Heat Loss and Size of Heat Recovery Equipment

b. Reduced Cost of Chemicals and Equipment For Water Treatment

NEW YORK

FOSTER WHEELER

ENCO
OIL and GAS
BURNER UNITS



Enco type K oil burning unit

High load or low, you can count on completely uniform combustion and greater fuel economy with the Enco Type K Oil and Gas Burner Unit. It is flexible three ways . . . (1) designed for use with either oil or gas—or both, (2) flexible where steam demands swing sharply and (3) can be operated by either natural or forced draft.

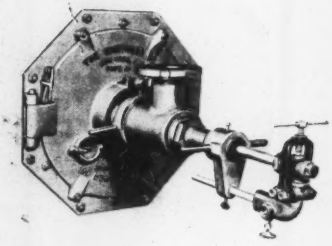
ENCO BURNER UNITS ARE MADE in many sizes to suit all capacity requirements.

Enco Interchangeable Atomizers

Wide Range Mechanical—Capacity range of 10 to 1. Manual or automatic control. Constant high oil pressure at atomizer insures efficient atomization over entire load range without recirculating or returning oil.

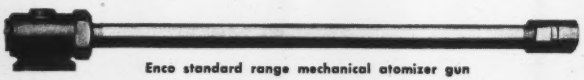
Steam or Air—Capacity range of 10 to 1. Controlled by manual or automatic pressure regulation.

Standard Range Mechanical—Available in all sizes to suit load and capacity requirements.

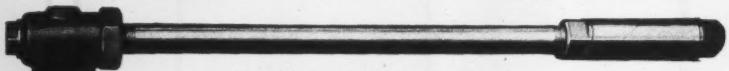


Enco type K gas-oil burning unit

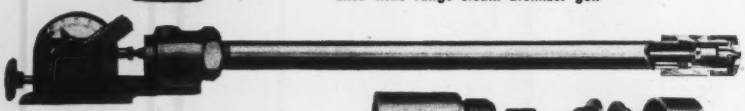
BULLETINS ON REQUEST
WRITE TODAY



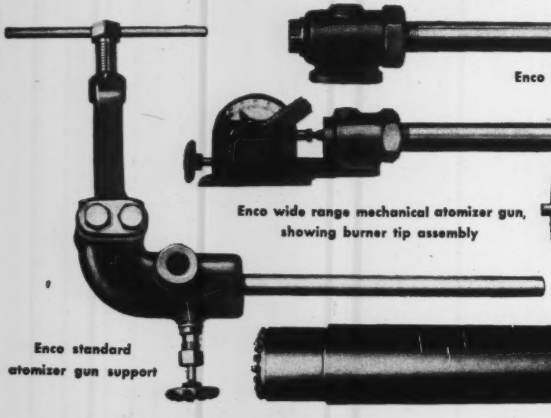
Enco standard range mechanical atomizer gun



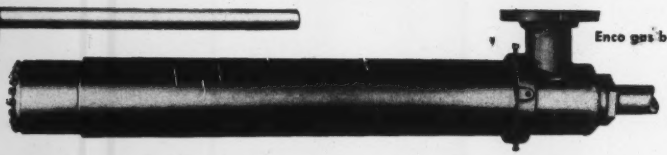
Enco wide range steam atomizer gun



Enco wide range mechanical atomizer gun, showing burner tip assembly



Enco standard atomizer gun support



Enco gas burning gun

EC-482

THE ENGINEER COMPANY 75 WEST STREET, NEW YORK 6, NEW YORK

IN CANADA: F. J. RASKIN, LTD., 4220 IBERVILLE ST., MONTREAL 34 P.Q.

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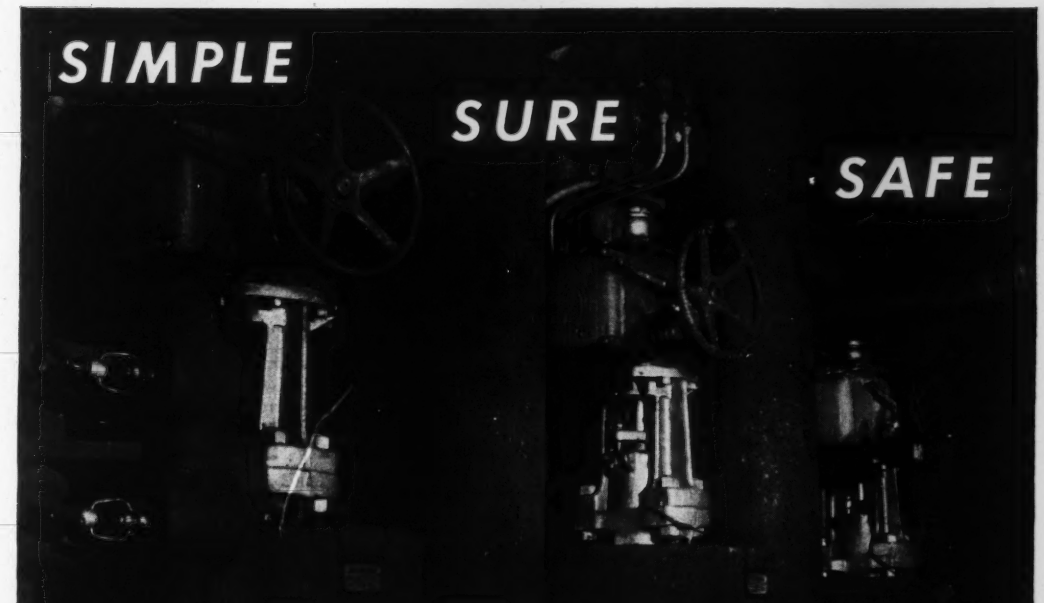
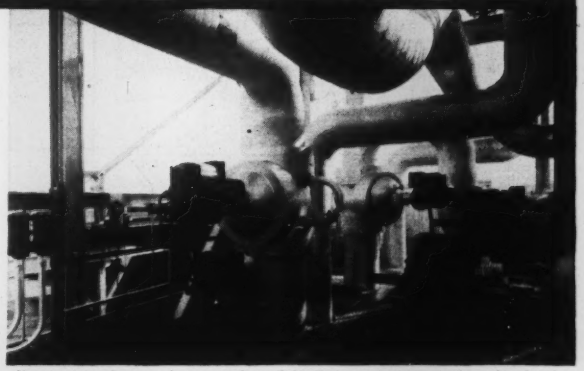


LIMITORQUE REMOTE CONTROL

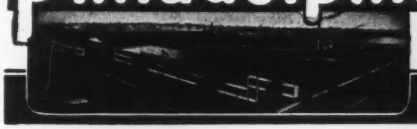
From coast to coast, indoors and out, thousands of LimiTorque Valve Controls are providing push-button operation of valves of all types in Central Stations, Industrial Power Plants, Hydro-Electric Plants and other Public Utilities. This operation may be either by remote or nearby control panels. LimiTorque prevents damage to stem, seat, disc, gate or plug, because the Torque Seating Switch limits the torque and shuts off the motor before trouble can occur. Actuation may be by any available power source: electricity, water, air, steam, gas or oil. LimiTorque may be supplied by your valve manufacturer.

Write for a copy of the LimiTorque Catalog. Please use your Business Letterhead.



Upper view shows a large number of LimiTorques in one station of a large eastern public utility company. Lower photo pictures a few of many LimiTorques at a large California electric plant. Many more are installed in other plants of this company.

Philadelphia Gear Works, INC.



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Industrial Gears and Speed Reducers — LimiTorque Valve Controls

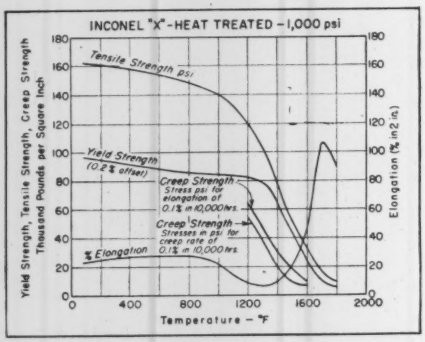
INCONEL "X"

An oxidation-resisting alloy with very high strength over 1000°F

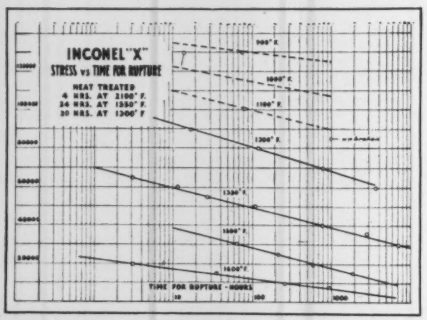
Inconel "X"® is an age-hardenable alloy which is unusually strong both at ordinary temperatures and at red heat. Suitably heat-treated, Inconel "X" has low creep rate under high stresses over 1000°F—and exceptionally high spring properties up to 1100°F.

The principal engineering characteristics of Inconel "X" (besides those shown on accompanying charts) are:

- **Oxidation Resistance**—Tests indicate that oxidation resistance of Inconel "X" is of the same order as that of Inconel.
- **Fatigue Strength**—Measurements of fully heat-treated Inconel "X" on rotating beam machines, at 100,000,000 cycles, show fatigue strengths ranging from 55,000 psi at 1200°F to 36,000 psi at 1500°F.



Short-time high-temperature properties of fully heat-treated Inconel "X".



High-temperature stress-to-rupture properties of fully heat-treated Inconel "X".

- **Impact Strength**—For fully heat-treated Inconel "X", typical impact strength values are: 33 ft. lbs. at −320°F, 37 ft. lbs. at room temperature, 67 ft. lbs. at 1500°F, and 113 ft. lbs. at 1600°F.
- **Hardness**—By proper heat treatment, the room temperature hardness of Inconel "X" can be developed as desired from BHN 140 to BHN 400.
- **Spring Properties**—By a combination of heat treatment and cold working, Inconel "X" develops unusually high spring properties. For spring applications from sub-zero temperatures up to about 650°F, it is useful where otherwise unusually strong ferrous springs must be used. Up to 1100°F, Inconel "X" springs will give useful performance where few other metals can be relied on.
- **Machining**—Inconel "X" is machinable in all conditions. Because of its strength and toughness, it cannot be machined as easily as softer metals; it can, however, be machined at entirely satisfactory rates.
- **Forging**—No unusual difficulties are encountered in forging Inconel "X", though heavier equipment than that used on ordinary steels is required.
- **Welding**—Inconel "X" can be welded by nearly all commonly used methods including: metal arc, inert gas metal arc, atomic hydrogen arc, resistance spot and seam, resistance butt welding. Satisfactory joints have been made between two parts of Inconel "X", and also between Inconel "X" and other alloys including standard Inconel, Stainless Steels types 310 and 347, and cast Stellite 21 and 30.
- **Applications**—Inconel "X" is used in gas turbine rotor wheels, blades; heavily stressed bolts; expansion bellows; valve springs in resonant jet engines . . . wherever a combination of high stress and extreme heat must be met.
- **Forms Produced**—Inconel "X" is supplied in most commonly used mill forms—billets, rod, flats, rounds, hexagons, sheet, strip, bar, wire, seamless tubes, and welding rods.

FURTHER DATA AVAILABLE

Inconel "X" is now in urgent requirement for critical defense applications, and we cannot say now just how soon we will be able to supply it for normal uses again. But you can get detailed information about Inconel "X" in your return mail by writing for our 79-page reference manual "Inconel 'X' " Data and Information.

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street, New York 5, N. Y.

EMBLEM OF SERVICE

NICKEL INCO ALLOYS

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL • "S"® MONEL
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MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 73 NUMBER 4

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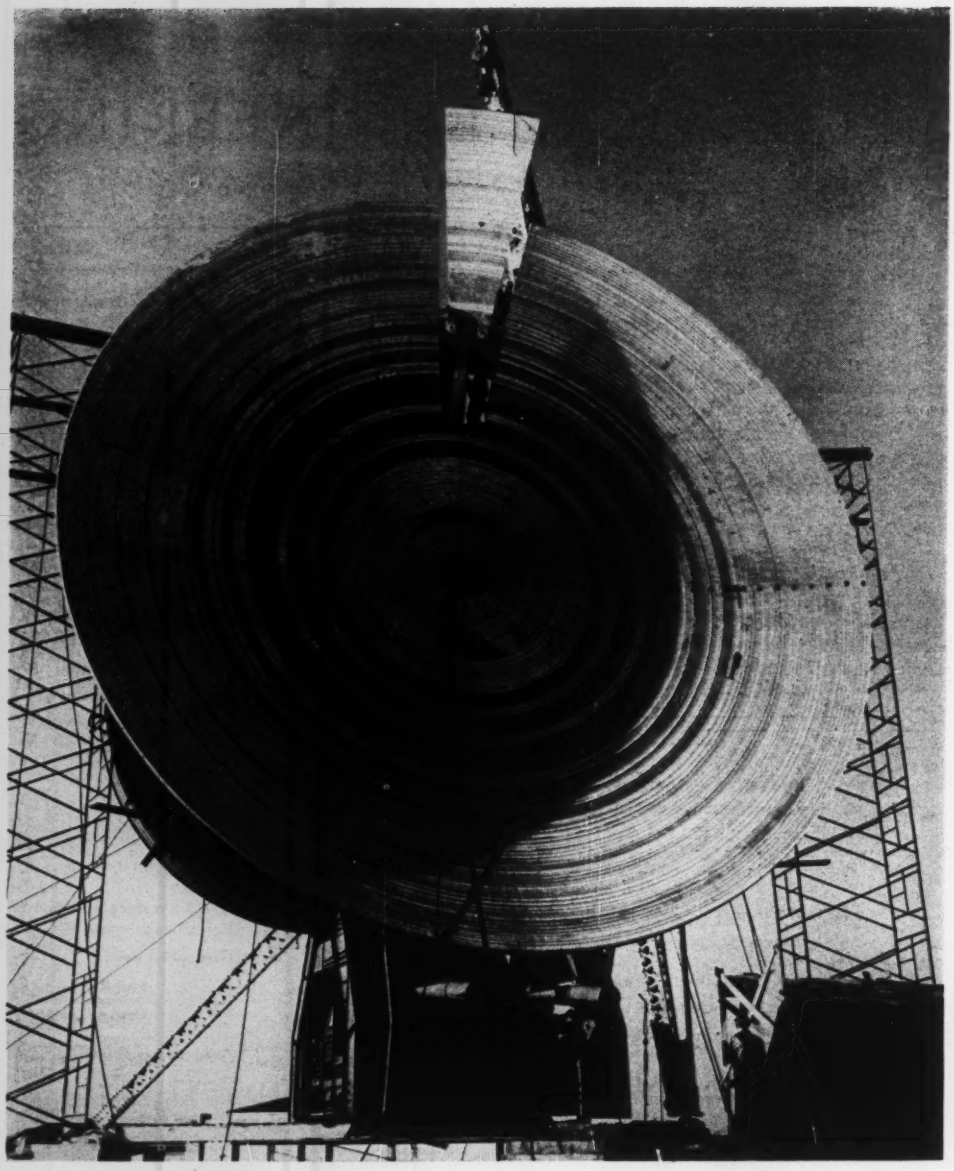

Official Defense Department Photo

Astronomical Studies to Be Extended by This New Navy Radio Telescope

(Workmen lower last section of Naval Research Laboratory's 600-in. radio telescope into place. With this installation, NRL scientists will study radio "signals" from the sun, moon, and stars. Information gained from these radio astronomy studies is expected to extend man's knowledge of the universe and to be of practical application in long-range weather forecasting and in radio communication. A description of the installation appears on page 330 of this issue.)

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GEORGE A. STETSON, *Editor*

William Lamont Abbott

WILLIAM LAMONT ABBOTT, past-president and honorary member of The American Society of Mechanical Engineers, whose death occurred on Feb. 20, 1951, was one of the pioneers of the electric light and power industry. His life span covered the remarkable era which witnessed the beginnings of central stations as small plants, serving a single building or a group of buildings in a single block, to large systems of generating stations with transmission lines crossing city and state lines and drawing metropolitan, industrial, suburban, and rural areas into a vast network with interconnections with other similar networks. The amazing contrast which this span of years affords is revealed by the statement which appears in Mr. Abbott's application for ASME membership, dated Oct. 2, 1891, which reads "operates an electric light plant of 300 hp capacity." How fondly he regarded that particular area of responsibility in the power and light industry is shown by the fact that from 1899 until his retirement in 1935 Mr. Abbott bore the title of "chief operating engineer" of the Commonwealth Edison Company of Chicago. He was a recognized authority on the efficient and economical operation of large steam-electric generation and an active and vigorous proponent of coal conservation and improved coal-mining and coal-handling methods.

Mr. Abbott was born in Whiteside County, Ill., on Feb. 14, 1861, and was graduated from the University of Illinois with the degree of ME in 1884. He served his alma mater as a member of the Board of Trustees, elected "by the people," from 1905 to 1923, during which interval he was twice (1907–1909 and 1921–1922) president of the Board. In 1929 the University conferred on him the honorary degree of LLD.

In the fall of 1879 Thomas A. Edison announced the invention of the commercial incandescent lamp, which was to give such strong impetus to a new industry, and in 1882, while Mr. Abbott was still at the University, the first real central station, Pearl Street, was put into service in New York using Mr. Edison's direct-current machines. It was with this infant industry that the young Abbott cast his lot. After he had acquired shop and drafting-room experience he was active in the organization, in 1887, of the National Electric Construction Company of Chicago, and became its president and general manager. When the company was absorbed by the Chicago Edison Company (now the Commonwealth Edison Company) in 1894, Mr. Abbott was employed by that concern and in 1895 was chief engineer of the Harrison Street Station, built in 1893. This station contained 10 boilers of 500 hp each, developing saturated steam at 160 psi, and direct-connected vertical reciprocating steam engines having a combined capacity of 6400 kw. In 1889 he was promoted to the position of chief operating engineer of the company, which he held until his retirement in 1936 after 50 years of central-station operation.

From 1907 to 1910 Mr. Abbott served on the Council of The American Society of Mechanical Engineers as a manager. In 1921, when the Society held its Spring Meeting in Chicago, he presented a paper, "Location and Distribution of the Central-Station Power of the Middle West." In that area, rich in coal but relatively poor in high-head water-power sites, there was at that time a developed central-station capacity of 4.5 million kilowatts, "of which all but 18 per cent is from steam power." The "low, level, rich prairie country with its wealth of cheap coal," in which power had to be used where it was generated, had been greatly developed and benefited by electric transmission, which, as Mr. Abbott put it, "has changed all this, and whereas once factories went to the power, now power goes to the factories." Thus the "ever-widening effective range of transmission lines and higher cost of coal" would involve development of additional water-power sites, greater urgency for coal conservation, and problems of state regulation.

In his ASME Presidential Address delivered in December, 1926, Mr. Abbott discussed the changing relations between employer and employee. Speaking in the prosperous era which followed the postwar slump of the early 1920's, he held out great hopes for mutual trust and understanding: "Justice to the employer, justice to the employee, and justice to the public." And in describing the part the engineer was to play in the new industrial era, he said: "When we fully realize that industrial relations are a major and not an incidental problem of production and that the employee's co-operation, welfare, self-respect, ways of thinking, and humors are major ingredients of success, and when we respect and use them accordingly, then we may visualize on our shores another statue of gigantic proportions, typifying America lighting the way to industrial freedom, prosperity, and peace."

After his retirement in 1936 Mr. Abbott exercised his talents in other engineering ventures. He received many honors. He was a Fellow and honorary member, ASME, a Fellow of The American Institute of Electrical Engineers, a member and past-president of the Western Society of Engineers, and twice recipient of the Chanute Medal of that society. In 1942, when he received the Washington Award, the citation read "for advancing the standards of the engineering profession, for services to higher education, for aiding combustion research."

AIR-POLLUTION PREVENTION *in the* UNITED STATES

By J. F. BARKLEY

CHIEF, FUELS UTILIZATION BRANCH, BUREAU OF MINES, DEPARTMENT OF THE INTERIOR, WASHINGTON, D. C. FELLOW ASME

HISTORY OF ADOPTION OF ORDINANCES

ONE of the early cases in the United States, if not the first, in which smoke was adjudged a nuisance was a private suit at law in the City of St. Louis in 1864, involving damages amounting to $50 (1).[1] There followed in that city, in 1867, the adoption of an ordinance requiring that all chimneys of manufacturing establishments be at least 20 ft above the adjoining buildings. Its enforcement apparently came under the Fire Department; at least, its chief engineer was to notify all "parties." A fine of not less than $10 nor more than $100 was provided for violation. According to Johnson (2), probably the first legislation in the United States to control fumes was the ordinance of Oakland, Calif., enacted in 1872, prohibiting erection or maintenance of any smelter within the corporate limits of the city.

The first ordinance giving a local government specific authority to prevent smoke was adopted by Chicago in April, 1881 (1). It stated, "the emission of dense smoke from the smokestack of any boat or locomotive or from any chinney anywhere within the city shall be a public nuisance." The fine for violation was $5 to $50. The enforcement was divided between the police and health departments. No standards of smoke density could be maintained, and many believed that smoke could not be prevented. Cincinnati adopted a smoke ordinance in November, 1881 (3). In 1893 (1), St. Louis adopted an ordinance declaring the emission of "dense black or thick gray smoke" to be a nuisance, and, at the same time another ordinance "authorizing and providing for the making of regulations limiting and defining permissible smoke emissions, and for the testing of smoke-prevention devices and the making of such tests and experiments as may be deemed advisable with a view to the abatement or suppression of the smoke nuisance." A few years later, the first bill was declared to be invalid chiefly because it did not state that the smoke would be suppressed "when it becomes a nuisance to property or health or annoying to the public at large." This was corrected in 1899.

About the turn of the century, many cities adopted ordinances, some of the earliest being Washington, D. C., Philadelphia, Pa., and Baltimore, Md. About 1912 the Bureau of Mines made a survey of city smoke-abatement ordinances (4). It was found that 12 cities of less than 50,000 population had either a smoke ordinance or an official charged with smoke inspection; about 17 cities of 50,000 to 200,000 population were making more or less vigorous efforts to suppress smoke, the more active at the time being Des Moines, Iowa; Lowell, Mass.; Syracuse, N. Y.; Toledo, Ohio; Richmond, Va.; and Atlanta, Ga. Of the 28 cities having over 200,000 population, 23 were active in the effort to abate smoke. Indicative of opinions at that date was a reply from one city that smoke has been found "a nuisance that cannot be abated—for the reason of its being a manufacturing city." In Richmond, Va., an ordinance was passed prohibiting the use of any fuel except anthracite in certain sections of the city without a permit from the city council; this ordinance was afterward declared unconstitutional.

Few counties to date have adopted ordinances. As a result of smelter difficulties, Contra Costa County, Calif., in connection with a comprehensive investigation, ended about 1915, by the State "Selby Smelter Commission," adopted an ordinance aimed at smelters, limiting "fume" strength. The first outstanding case of county general ordinance and activity was that of Hudson County, N. J., the ordinance being adopted in 1931. In 1947 Los Angeles County, Calif., through a State enabling act, adopted a comprehensive ordinance. In 1949 Allegheny County, Pa., developed a broad ordinance.

There has been some state activity in regard to passing laws aimed at smoke abatement. In 1909 Rhode Island adopted a law prohibiting "the emission of dense or thick black or gray smoke—for a longer period than five minutes at any one time within any city of the State having a population of 150,000 or more;" private residences and "locomotives during the time of starting and feeding fires therein while in roundhouses or roundhouse yards" were excepted. In 1910 Massachusetts adopted a law for the general area of Boston prohibiting emission of smoke, the denseness of which was based on Ringelmann chart readings. Other earlier states enacting legislation include Iowa, Missouri, Louisiana, Ohio, Pennsylvania, and Wisconsin. One state starts out a section with "Where smoke consumers are required." State laws are usually laws giving authority to cities to abate smoke.

The Federal Government has passed no smoke-abatement laws relating to the nation, but did pass one for Washington, D. C., which comes under its jurisdiction.

As air-pollution-prevention ordinances were being developed and adopted throughout the country, various "model" or "example" ordinances appeared. In a Bureau of Mines Bulletin, 1912 (4), ordinances were suggested for small cities of about 20,000 population, for cities of 50,000 to 200,000, and for cities over 200,000. These were based largely upon the ordinances, at that time in effect, of Chicago and Des Moines. In 1924 a basic ordinance was prepared by a committee of representatives of the American Society of Heating and Ventilating Engineers, the Stoker Manufacturers Association, the American Civic Association, The American Society of Mechanical Engineers, and members at large (5). This was a rather comprehensive ordinance that included engineering regulations as to equipment dimensions required. It was widely studied at the time and served as a guide for many cities. In 1938 the Smoke Prevention Association published a model smoke-abatement ordinance of eight sections (6). In 1949 the ASME published an information bulletin entitled "Example Sections for a Smoke Regulation Ordinance," prepared by a committee of the Fuels Division (7). Fifteen example sections were included, together

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Fuels Division and presented at the Annual Meeting, New York, N. Y., November 26–December 1, 1950, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

with many informational comments. The sections have been used as a basis for law by more than 100 cities in making changes in and adopting new smoke ordinances, and form the basis of the recommended smoke ordinance of the Coal Producers Committee for Smoke Abatement.

EMISSIONS PROHIBITED AND STANDARDS OF MEASUREMENTS

In the earlier years, the word "smoke" included just about all the air contaminants, even some arising from natural causes. In a 1915 report of a classic scientific study of contaminants from a smelter, it was stated that "the smoke of the Selby smelter is composed of three different classes of material—dust, fume, and gases" (8). In a 1915 Bureau of Mines bulletin, entitled "Metallurgical Smoke" (9), the smoke was defined as "gases and vapors, and the fine dust entrained by them, that issue from the throat of furnaces, such as blast furnaces, reverberatory smelting furnaces, or roasting furnaces." It further states, "at some plants the amount of metallurgical smoke is very great, exceeding in weight that of the solid material charged into the furnaces." Early city ordinances merely used such words as dense black or gray "smoke." Hand-firing predominated; and the carbonaceous particles produced, easily seen, were considered the nuisance. People did not become particularly excited over sand and dust until the many paved roads caused much of these to disappear. Along with road development came coincidentally the big increase in forced-draft equipment, which tends to throw ash rather than carbon particles out the chimney. This was termed "fly ash" for many years. Progress and analytical work finally resulted in smoke being defined as small gas- and air-borne particles (usually not larger than 1 micron in mean diameter) consisting essentially of carbonaceous material, in sufficient number to be observable (7). Fly ash usually contained much carbon, so the general term "dust" was devised in 1941; this was defined as gas and air-borne particles larger than 1 micron in mean diameter (10).

Progress required that the term "dense smoke" be defined. Two schemes appeared—comparison with a chart showing different shades from 20 to 80 per cent black, known as the Ringelmann chart, and comparison with colored glass, known as the Umbrascope. The chart was first used extensively in fuel testing in 1904, by the Technologic Branch of the U. S. Geological Survey, which later became the Bureau of Mines. Experience with the Ringelmann chart and the Umbrascope led to almost universal use of the former. To provide this standard, the Federal Government, since 1908, has printed Ringelmann charts for general free distribution (11). Many objections have been raised to the shade method of judging the amount of smoke coming from a stack, such as the effects of the diameter of the stack, the cloud and wind conditions, and the human element in judging shade, all of which are considered to affect the result. These comments and objections, however accurate, become inconsequential when the entire purpose of the readings is considered. The purpose is not merely to fine some violator because smoke of a certain shade has been emitted, concerning which it may be argued just what percentage of blackness occurred or how many black particles were emitted. The purpose is to lessen smoke emission and to improve co-operation in making a cleaner neighborhood. The smoke-chart scheme has proved effective and is simple; moreover, no more practical method has yet been devised. Occasionally "smokes" are not made up of black particles. The Ringelmann shade is not applicable in such cases. The ordinance of Los Angeles County covers this by adding to its shade limitation "or of such opacity as to obscure an observer's view to a degree equal to or greater than does smoke—" of its Ringelmann shade limitation.

Although a number of city ordinances still use the term "dense smoke," many ordinances have emission limitations based on shades of gray for certain lengths of time. These limitations vary considerably in city ordinances, their differences indicating the many different conditions involved in each area. In the ASME "Example Sections" (7), a basic smoke limitation is suggested and discussed.

The problem of setting a dust limitation has become quite involved and controversial. At first, the limitation was on a simple "nuisance" basis. Plant operators objected that such a limitation was unreasonably indefinite. The City of New York in 1938 set a definite limitation of 400 grains of "cinders" per 1000 cu ft of gases, omitting to mention, however, the temperature of the gases. In 1940 St. Louis set a figure of 0.75 grain per cu ft of flue gas at stack temperature, of which amount not to exceed 0.2 grain per cu ft should be of such size as to be retained on a 325-mesh sieve, the mention of size indicating that larger sizes were considered more of a detriment than smaller sizes. The ASME "Example Sections" (7) recommended a considerably lower limitation, in which size discrimination was ignored. The reasons for this choice, in keeping with air-pollution work, were many and varied. They are covered in the publication under "Comments on Section 8." Recently a committee of the Air Pollution and Smoke Prevention Association has submitted a report on a proposed dust limitation that has a somewhat different basis. In general, it has appreciably higher or easier dust limitations for smaller plants and appreciably lower for the larger plants than those of the ASME. Approaching the solid-particle air-contaminant problems from the standpoint of nonferrous, steel, gray iron, and electric iron metallurgical industries, Los Angeles County adopted in 1949 a range of limitations on allowable discharge per hour of solids based upon weight per hour of process material.

The only method to date of determining dust emission is included in the ASME Test Code for Dust-Separating Apparatus (10). The test requires equipment, trained personnel, time, and money that are not available for many city smoke-regulation departments. It appears that, in such cases, the operator would have to pay the expense. All in all, it is a nice problem.

Difficulties from sulphurous gases first became prominent in the Far West, such gases being produced by large-scale metallurgical processes. The Report of the Selby Smelter Commission of 1915 included much information on these difficulties (8). Sulphuric acid forms from these gases and attacks virtually everything. Sulphurous gases are produced not only metallurgically, but also from the combustion of fuels, the amount being essentially in proportion to the sulphur content. In general, there has been little legislation against sulphur in ordinances. In 1937 St. Louis passed an ordinance in which it was stated that no coal should be consumed "in sizes that will pass through a two-inch (2") circular opening or its equivalent, which contains in excess of either twelve per cent (12%) ash or two per cent (2%) sulphur on a dry basis, unless such coal—has been—washed, etc." In 1949, Los Angeles County limited at the point of discharge "sulphur compounds (calculated as SO_2) 0.2 per cent by volume." Methods of determination or measurement include sampling and analyses that require considerable scientific technique. There are many air contaminants other than smoke, dust, and sulphurous gases. In much of the past these were, in general, ignored. In time mention began to appear of summary terms, such as pungent, noxious, offensive, disagreeable, or "noisome" odors, noxious gases, noxious or nauseous vapors, noxious acids, fumes, soot, and debris. These are put on a nuisance or "detrimental" basis.

DEVELOPMENTS IN CONDUCTING THE WORK

After passing through the adopting-of-an-ordinance stage, it quickly became evident that the work was only begun, and that an ordinance was little more than an expression of desire that gave government personnel an authoritative position. It began to be realized that the problem was a big, even a tremendous, one, involving legal, scientific, economic, and, particularly, human aspects.

As the problem became better understood, it was necessary to change the ordinance from time to time. Struggling with equipment already installed, the idea developed that all new equipment should be built properly to protect the future and inherently assure that, as the older equipment was abandoned, conditions would improve. Chicago, in 1907, was the first city to provide that there could be no construction of new steam plants or reconstruction of old plants without a city permit as to design (12). This proved very satisfactory and is now used practically universally. With the authority to decide final design details, the question as to what those properly should be immediately arose. Over-all costs of equipment were affected, as well as competitive positions of different types of equipment. After some 40 years, there is no common standard of equipment dimensions, there being great variations in city requirements for the same type of equipment under the same conditions of operation. This was brought out in a recent Bureau of Mines survey (13).

Somewhat along this line, the idea occurred that, even if built properly, poor maintenance could result in a condition conducive to illegal smoke production. Chicago, in 1938, established an annual-inspection scheme to assure that plants were maintained properly in so far as smoke production was concerned (12). This proved successful and many plant owners were benefited. Other cities have adopted this idea. The ASME "Example Sections" (7) include it.

In attempting to abate smoke, particularly from nonanthracitic coal, there have arisen much controversy and different decisions over the kind of coal that would be permitted for use. At one extreme is the statement that the only way to assure no smoke is to use a fuel that cannot smoke under any conditions. At the other extreme is the statement that anyone should be permitted to use any fuel he wishes, since he commits no wrong except when he makes smoke. Various volatile limitations for coal have been used in a number of ordinances aimed chiefly at abating smoke from hand-fired equipment. The controversy continues, but general progress should in time reach a settlement that all consider reasonable.

Changes in available fuel supplies, progress in design of equipment, and advances in the art of fuel burning resulted in the conception that a basic ordinance should be passed that provided for the adoption of "rules and regulations." These could be changed by delegated authority without having to go back to the lawmaking body. This is now general practice, although some prefer to get everything possible in the body of the ordinance.

In administering the ordinance, much experience has been gained in working with the "public." The use of the velvet glove and also, at times, the big stick, appears to be necessary. Hearty co-operation of the public is highly valued and very necessary. Enlistment of the help of local organizations, and general educational programs all have had a part. In 1919 Salt Lake City, Utah, obtained the services of the Federal Government on its air-pollution program. The Bureau of Mines made an extensive study there and set a general pattern for such work that has been followed essentially ever since (14). However, such comprehensive services to a city from the Federal Government have not been available for many years. Universities and industrial organizations have aided cities on specific problems. In recent years, the Coal Producers Committee for Smoke Abatement has done outstanding work with a great number of cities.

RELATED ACTIVITIES

Adoption and administration of ordinances have been accompanied by a vast amount of activity relating to air pollution—engineering, technical, and scientific.

To prevent the emission of smoke and dust, studies in combustion and in design and operation of fuel-burning equipment have been made by numberless individuals, manufacturers, and organizations of many types—industrial, technical, and governmental. Great progress in fuel-burning equipment has been made over the past 50 years, but the problem continues to call for more progress. Small, magazine-type, smokeless, hand-fired furnaces for bituminous coal, extensive use of overfire air on large furnaces and locomotives, greatly improved smoke and dust collectors, and the cyclone furnace, all are examples of relatively recent progress. Most of the studies made in this country on preventing emission of sulphurous contaminants from fuel-burning equipment have been made by the University of Illinois (15).

Such work is also progressing in other fields, such as metallurgical, and oil and rubber manufacturing. More information on types of gases emitted is being obtained; the development of new types of scrubbers for equipment considered, up to a few years ago, in the hopeless class is only one item of recent progress. A number of such studies are under way in Los Angeles County, Calif., and Allegheny County, Pa.

Although the only place to prevent air contaminants from reaching the air is at their source, much related scientific study and many investigations have been made as to what and how much is in the air. The many determinations made at various places, seasons, days, hours, and minutes have shown that the variations in contaminants at a given point, even from minute to minute, may be quite wide, depending on many factors, particularly the weather. Much work is yet to be done on methods of identifying and determining accurately the amounts of many contaminants in air. Universal accepted standards as to sampling and analyzing do not exist.

In city air-pollution-abatement work, the question frequently arose as to whether or not general air conditions were being improved. The idea of making "soot-fall" determinations developed in which open containers were placed at various chosen spots throughout a city. Results of work on such schemes have not been as satisfactory as desired. A number of containers placed close to each other would show considerably different falls of solids. The lighter the solid particle, the less was the chance of its falling into the container. However, such determinations have been made in a number of cities, Cincinnati having a continuous record since about 1930. No standard as to equipment and procedure for "soot-fall" determinations has been accepted generally, and such records cannot be used satisfactorily for comparing different cities. The general opinion is that soot-fall records, if taken for some years, will contribute some knowledge as to general conditions. Along this general line, some use has been made of the Owens automatic filter, a recording instrument that filters a continuous sample of air, the depth of color on the filter resulting from the solids contaminants giving relative results. Another comparative scheme tried has been based upon records of visibility from chosen points of observation. This contributes some information.

From a practical standpoint, there is no "pure" air; a reasonable basic standard of air as found in farm or forest areas has various natural contaminants of gases and dusts. The problem has been worked upon with the idea of establishing what

maximum quantity of each of the many contaminants should be permitted. Such values have not been established satisfactorily.

Scientific study for many years has been made on the relationships and effects of weather conditions on air pollution. Of the various meteorological effects, that of wind velocity was most easily understood generally. There was evolved a new word "smog"—a combination of smoke and fog. Relatively recently, there has been appreciably increased understanding by the public of the phenomenon called "temperature inversion." Such knowledge is helpful in working on air-pollution problems, but to date nothing much has been done about the weather to abate air pollution. Possibly the present studies being made to cause rain, may in time lead us to thinking about effective operating procedures concerning the weather that appear quite beyond us at present.

For better understanding and for determining proper justification for air-pollution abatement, investigations have been made of the damaging effects of air pollutants on property, vegetation, and health. Considerable is known about property damage, particularly the effects of dust and sulphuric acid, at least qualitatively.

In the report published in 1926, covering the Bureau of Mines investigations at Salt Lake City (14), the following statements as to property damage were made:

"Many of the facts involved are variable and indeterminate. . . . .An attempt to define the extent of losses regardless of the manner in which they arise at once discloses the lack of a definite or reliable standard of measure."

It appears now, 25 years later, that the statement still is essentially applicable. Questions frequently have arisen as to the dollar damage to property from city air pollution. The Mellon Institute estimated that in Pittsburgh over $2,000,000 was spent in 1913 on extra laundry and dry cleaning of clothing, $750,000 on cleaning and renewal of wall paper and curtains, and more than $2,000,000 by merchants to protect merchandise and replace losses due to smoke (16). Estimates of losses per annum for various cities range from some $6,000,000 to $30,000,000. All such estimates are educated guesses but do show that the losses are in the millions of dollars.

Our knowledge of the effects of contaminants on vegetation is on a much higher scientific basis. Studies include effects of sulphurous contaminants, fluorine, tars, and dusts. In the Report of the Selby Smelter Commission published in 1915 (8), mention is made of previous work on the effects of SO_2 in air on vegetation. Considering such work not particularly satisfactory and having wide divergences in the conclusions, an extensive study was made on growing grain. About 1935 an international problem was taken up by Canada and the United States on damage to vegetation in the State of Washington from SO_2 emitted from the smelters of the Consolidated Mining and Smelting Company at Trail, British Columbia. This resulted in further comprehensive studies on damage to vegetation (17). Work has continued, particularly in recent years, on damages from fluorine.

As regards the effects of air pollution on health, the following is quoted from a Bureau of Mines Bulletin, 1926 (14), which illustrates the beliefs at that time:

"1 There is a general agreement among sanitary authorities that polluted air is harmful to health.

"2 At the present time there is no accurate method of measuring this harm nor of determining the relative responsibility of the different elements that enter into the mixture of gases and solids commonly referred to as atmospheric air.

"3 The direct effect of smoke or any of its attributes, including soot, dust, and gases, in amounts which may ordinarily pervade the atmosphere of a smoky city is not shown to be detrimental to persons in normal health.

"4 The direct effect of smoke upon those who are ill has been most extensively studied in connection with tuberculosis and pneumonia. It appears that smoke does not in any way stimulate the onset of tubercular processes nor militate against the rapidity of recovery when once this disease has been contracted, but that it has a direct antiseptic effect and tends to localize the disorder. In cases of pneumonia the effect becomes seriously detrimental.

"5 In addition to these direct effects, indirect effects result from the diminution of sunlight and the increase in fogs, clouds, and haze.

"6 The general physical tone is lowered as the result of long-continued breathing of polluted air."

Twenty-three years later, in 1949, an outstanding medical authority stated (18):

"Industrial fumes and gases do not occur in the general atmosphere to an extent to cause disability or death, except in very unusual and rare instances. Industrial fumes and gases may constitute a nuisance and even at times irritation and inflammation of eyes and upper air passages. . . . .Smoke pollution . . . . can seriously interfere with general well-being and comfort. That it can cause specific disease or death to any considerable degree cannot be stated in the light of available evidence."

During this 23-year interval, much medical study has been given the subject. Although great progress has been made on air-pollution problems concerning inside workers, and standards have been established of maximum allowable concentrations of many contaminants, it is apparent that this is not true for general city-air conditions. The recent Donora case stimulated medical studies. It is interesting to note that the comprehensive investigation of this case resulted in the following statement (19):

"It seems reasonable to state . . . . that while no single substance was responsible . . . . the syndrome could have been produced by a combination . . . . of two or more contaminants. . . . Hence, the lack of fundamental data on the physiologic effects of a mixture of gases and particulate matter over a period of time is a severe handicap in evaluating the effects of atmospheric pollutants in persons of all ages and in various stages of health."

Another related activity is the preparation of summaries showing comparisons of contemporary city ordinances and the preparation of bibliographies on the thousands and thousands of papers relating to air-pollution work. Recent examples of the former are "An Analysis of Smoke Ordinance Regulations," 1947 (20), and "Legal Regulation of Air Pollution," 1949 (21). Bibliographies that have been published are listed at the close of this paper (22, 23, 24, 25, 26). There is now being prepared in the Bureau of Mines a comprehensive bibliography covering all phases of the problem.

GENERAL NATURE OF PROBLEM

After about a century of city air-pollution-prevention problems in this country, half of which have included considerable activity, the question naturally arises as to why better progress has not been made. Similar problems have been solved essentially in so far as contaminants in city water, milk, food, and drugs are concerned. Why has there been so much of "ups and downs" in air-pollution-prevention work? It is true that emphasis goes down during a war and greatly increases following the end of a war, but this does not account for that characteristic. Only recently, during an after-war period, one New Jersey county dropped the work on short notice after some 20

continuous years of outstanding work on air-pollution prevention that gained even international attention.

Various reasons have been advanced as to why air-pollution interest has "waxed and waned." City politics, lack of funds, organizational difficulties, the general "bigness" of the problem, the countless sources or points of production of contaminants, the economic impossibilities of stopping the emission of contaminants, and lack of continued public interest, all have been cited with good justification. "Campaigns" started by public-spirited men, women, organizations, or clubs can always entrain followers for a time. People are ready to unite and have emotions in correcting an evil, particularly a simple, visible one such as smoke or fly ash from commercial chimneys. But a campaign can last only so long, and followers get interested in something else. An all-including "air-pollution" campaign is not simple, involving many items not so easily understood, crossing many economic interests; it is somewhat indefinite in the minds of the followers, and they have difficulty in having needed campaign feelings.

The basic reason for the lag in air-pollution prevention is our indifference to or lack of fear of polluted air under all ordinary circumstances. The fact that we take in perhaps 3 to 5 times more pounds of air per day than food and perhaps 10 times more than water is given no thought. Even if automobiles continuously give out poisonous gases from incomplete combustion, we do not limit their use on city streets. People who would be horrified at the thought of giving their babies polluted milk or water are not particularly careful when it comes to polluting the air with tobacco smoke resulting from a combustion devised to be incomplete. When the medical profession instilled in the minds of people the fear of impure water, milk, and so forth, proper purification resulted. The desire for cleanliness, nondestruction of property, and better visibility has not proved enough to eliminate the pollution of city air to a satisfactory extent. It is up to members of the medical profession to do their part toward better living by establishing needed facts about city air pollution that will impress themselves and then the general public.

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Scientific Approach to Human Problems

I GATHER from my readings that very brilliant work is being done on the scientific approach to human problems but surely not at all in proportion to its importance.

Such scientific work evidently must overcome many prejudices. There is good reason to be concerned that improper conclusions will be drawn from incomplete data. This needs more and better, rather than less, scientific work. I can sympathize with the fear that facts may become well established, such as about the freedom of the will, which are incompatible with what we like to believe. Such adjustments have been made before. Few would take the position of not wishing to know the truth. Surely science should not supplant but supplement the agencies now working effectively for our betterment.

Nearly everyone welcomes the scientific work done in helping children develop normally and fully. The quotation "Men are but children of a larger growth" is both good literature and good science. We develop a great deal intellectually as we become adults but our emotional progress is not very marked. And emotions are the driving forces in our lives. . . . . In toys and games the adult and child are not far apart, nor are other appeals to our emotions, for example, in advertising and politics, at a much higher level. I have no great desire to change this even were it possible. In fact, most of us particularly like people who don't feel very grown up and can smile at themselves. It is men who haven't grown up emotionally and don't know it and cannot be told who are dangerous. Just now the world's emotional children are playing with fire.

Surely everyone should welcome whatever the intellect of man can find to help his emotional childishness. "The proper study of mankind is man" is more completely true today than when it was written. And a study with every technique and tool that man can devise, and in coverage and intensity commensurate with its importance.—Otto B. Blackwell, *Electrical Engineering*, March, 1951, p. 189.

The MECHANICAL ENGINEER *in the* CONSTRUCTION INDUSTRY

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UPON receiving a BS degree in mechanical engineering, the author became associated with the construction industry purely by accident. Having spent his entire business years in this industry, it has become clearly evident that many other mechanical engineers are also there by accident. This happens because of the general belief that this industry is the business of the civil engineers to the exclusion of all others. If this paper points out to some undergraduate the increasing importance of the mechanical engineer in the construction industry and is helpful to him in planning his future, it will have served its purpose.

GROWTH OF MECHANICAL FEATURES IN BUILDING CONSTRUCTION

Only a few years ago, actually within the memory of many adults, the only part of a construction job that could be classified as mechanical was the small amount of heating and plumbing work involved. Analysis of construction costs of the early 1900's indicates that in most cases the cost of such would not reach 5 per cent of the total. On some jobs, a steam hoist or a steam roller might have been used in the process of construction.

Very few residences, and only those in cities, had central heating systems. In sections where natural gas was available, a small percentage had gas lights and gas grates. Inside plumbing was becoming fashionable, and most homes within the incorporated limits of towns and cities had connections to some kind of central water supply.

Commercial buildings were heated, in most cases, by large stoves, and the plumbing facilities were very meager. Office buildings fared better in so far as plumbing and heating were concerned, a few boasted of gas lights, and the higher ones had simple elevators.

Industrial plants and warehouses occasionally had freight hoists and substantially no sanitation or lighting.

It can well be said that the mechanical engineer had only a very small place in the construction industry until after 1900. Since that date, however, his position in the industry has been becoming so much more important each year that today he is responsible for the design of approximately 25 per cent of the cost of all buildings. This figure is used with reference to all types of new buildings. He also plays a great part in the design of alterations and a substantial part in the design of that construction generally classified as heavy and highway.

The increasing importance of the mechanical engineer in the construction industry can be seen in numerous ways.

In 1929 the mechanical work required in buildings constructed for housing telephone exchanges ranged from 13 to 17 per cent. In 1949, in buildings designed for the same purpose, the mechanical work ranged from 27 to 35 per cent of the total cost. A good portion of this additional cost will be reflected in cheaper operating cost of the telephone exchanges. It provides for better lighting, control of humidity, and filtering of air in equipment rooms, and some comfort air conditioning for the human occupants.

In the past few years it has become common practice for estimators in the building industry to assume that mechanical costs will be 25 per cent of the balance of the structure. Only 10 years ago this figure was between 10 and 15 per cent.

The taller office buildings naturally have slightly higher mechanical costs. This is due to more elevators, water-storage facilities, and the installation of pumps to provide fire protection, water supply, and the like, for the upper stories, which are usually beyond the reach of normal services. Several buildings either completed, or now under construction, are listed in the following, and the percentage of the mechanical cost to total cost is given:

	Per cent
John Hancock Insurance Building, Boston	34
Mutual Life Insurance Co. Building, New York	33
Mellon U. S. Steel Building, Pittsburgh	39
United Nations Building, New York	38

About 1934 air conditioning began to show up in moving-picture theaters, and it was found to be a paying investment. This feature seemed attractive in other businesses and with the exception of the war years has been expanding rapidly. About the same time both new and remodeled buildings began using scientific lighting.

Businessmen will not spend money for improvements unless the expenditure produces adequate returns. During 1949 the nation's chain stores spent $31,000,000 for air-conditioning equipment. Such equipment is now operating in 18.5 per cent of all chain stores. Industrial uses of air conditioning have been expanding rapidly.

Alterations to provide improvements in existing structures represent approximately 50 per cent of all building-construction values. The portion of this work which comes under the jurisdiction of the mechanical engineer is much greater than in new buildings and approximates 50 per cent of the total cost. When combining new building construction, and alterations and additions to existing buildings, the portion in the hands of the mechanical engineer is in excess of 40 per cent of the total.

When it is remembered that just 50 years ago this same figure was not in excess of 5 per cent, there is no wonder that there is a shortage of mechanical engineers in the construction industry. It must be kept in mind that the foregoing is in reference to building construction only.

During the relatively short period of time in which the startling increases in demand for the mechanical-engineer's talents has occurred in the building field, there had been a parallel increase in the heavy and highway division of the construction industry.

MECHANICAL ENGINEERING IN HIGHWAY CONSTRUCTION

The rapid increase in highway travel has forced the construction of high-speed highways. With this, certain safety features such as lighting, safety signals, construction of vehicular tunnels with adequate ventilating and lighting, drainage, and so forth, have become necessary. There actually exist today two sections of public highway equipped with snow-melting

systems; one on the outskirts of Bridgeville, Pa., and one in Massachusetts. A combination of bad climatic conditions and grades has justified these installations. Other similar installations have been considered but did not prove in. Even in such instances the services of the mechanical engineer are required, to reach an intelligent decision. At least preliminary plans must be prepared and an estimate made of the cost. There have been numerous snow-melting systems installed in sidewalks, and these are proving very satisfactory. This is an entirely new field which has opened since World War II.

Until recent years when large masses of concrete were poured, the rate and size of pour were such that either there was not sufficient heat generated to harm the structure or the structures are not safe. We know today that special provisions must be made to cool large masses of concrete to avoid damage. This requires the design, construction, and operation of refrigerating systems, hence the services of the mechanical engineer are required in the design and construction of such structures as large dams.

Just as the mechanical engineer is being required more and more in the design of highways and appurtenances, the same has happened in other fields of transportation. Today our country is crisscrossed with a network of pipe lines for the distribution of oil, gasoline, and natural gas. Fifty years ago not one of these existed. Today our industries would be crippled if these pipe lines failed to function as designed by the mechanical engineer.

In the same manner the faster tempo of transportation has required faster, more efficient, and many more mechanical features in railroad construction, such as movable bridges and signal systems. All of these are built by the construction industry with the mechanical engineer designing and supervising their installation.

INCREASE IN USE OF MECHANICAL CONSTRUCTION EQUIPMENT

It is most astounding to look back over the last 40 years and to consider the changes that have been made by the mechanical engineer in the tools and equipment used by the construction industry. It was only 40 years ago that the Panama Canal was under construction. The French gave up their attempt to complete a canal in 1904, when the U. S. Government took over their equipment and continued the work. The French claimed to have had the most modern equipment available. The Americans secured additional and improved equipment and started to carry to completion the largest operation of its type ever attempted. Mr. Joseph B. Bishop, Secretary of the Isthmian Canal Commission, wrote in his book "The Panama Gateway," published in 1913, as follows:

"Taken as a whole, the efficiency of the American plant was about five times that of the French." A list of equipment used on this project shows the largest piece to be a 90-ton steam shovel equipped with a 5-yd bucket. The total excavation was in excess of 266,000,000 cu yd. How different the job would have been if the equipment had been of 1950 models. All of the improvements have been made by mechanical engineers working with the construction industry.

One does not have to be in the construction industry to realize the magnitude of the improvements in tools and equipment that have appeared in a very short period of years. This is true not only of the larger and more spectacular pieces such as shovels, cranes, derricks, and pile drivers, but includes the smaller tools. In this category come such items as drills, portable saws for both wood and masonry, vibrators for concrete and forms, concrete screeds and finishing machines, drills, cutters, trucks, hoists, and probably most important, the transit-mix concrete truck. These are the tools we are using today most of which were unknown a mere 50 years ago.

MORE MECHANICAL EQUIPMENT IN HOMES OF TODAY

The dwelling units being built today fall into one or other of two principal categories—the individual house built for the owner-occupant, and multiple-dwelling unit for rental. Prior to 1930, great numbers of individual houses were built for rental purposes, but today it is difficult to find a new individual house built as an investment and to be rented. The main reason for this is economics. Most persons who require individual houses can, with the federal guaranteed mortgage, secure title to a house with a relatively small cash outlay, and pay off the obligation with monthly payments of approximately the usual rental figure. This will no doubt continue with the present trend of social legislation now prevalent in the Federal Government. In the two types of houses that will be built during the ensuing years, the services of the mechanical engineer will be required more and more to insure proper design. Whether it is the private home or the multiple rental unit, the design should be such as to include initially or provide for later installation of the most modern domestic appliances and appurtenances.

These are numerous, and include central heating, modern lighting with adequate facilities for various electrical appliances, cooking ranges, refrigerators, garbage-disposal units, home laundry equipment, water softeners, humidifiers, mechanical and electrical air filters, air cooling, incinerators, insulation and acoustical treatments, lawn sprinklers, garden irrigation, snow melting for drives and walks.

No doubt a great many homes will include only a few of the items mentioned; however, the omission of any one is usually because of its cost, and its addition to the house may be possible sooner than we think. As an example, the mechanical refrigerator that is so commonplace today and a must in every home or apartment was only an idea in 1925.

The volume of work to be done in the housing field is astounding. Government statistics show that, since 1930, more dwelling units have been removed from service in the United States than have been created. During this same period the population has increased by approximately 20,000,000 persons. The housing administration established a goal of 1,500,000 units to be started in 1949. Only 800,000 were started. There continues a decided shortage of housing units and this will have to be eliminated. This job will be done by the construction industry, but the mechanical engineer will make enormous contributions to this work and will play a major role.

MODERNIZATION OF COMMERCIAL BUILDINGS

The situation with regard to commercial construction today is somewhat different from that found in the housing field. In housing, with a few exceptions of slum-clearance projects, new housing units are being built in outlying areas. Modern transportation makes it possible for a man to live many miles from his place of work. In commercial construction it is a case of providing modern accommodations on existing sites. This is being done by remodeling existing structures or razing old buildings and erecting new ones.

From an economic standpoint the commercial districts of most of our cities, particularly in the eastern portion of the United States, are in a deplorable condition.

These sections were built up prior to 1900, and it has been since that time that major mechanical requirements of a modern building were developed. In the average city it will be found that stores and shops occupy the first floor, and in many instances extend through two or more buildings. The upper floors are usually found to be storage space, low-grade office space, or unoccupied. If these buildings were equipped with modern features such as heating, lighting, ventilation, cooling, elevators, many would become profitable investments instead of obsolete real estate.

It is a proved fact that if one building in a community makes improvements, others will soon follow suit. Since the end of the war this trend of modernizing the out-of-date commercial districts of our cities has started. It will take many years of hard, but profitable work, by the construction industry and the mechanical engineer to exhaust this demand. By the time this is completed, newly developed features will be such that the entire job can be done over again.

A review of our manufacturing industry today, particularly that part other than the so-called basic industries, reveals that most plants are housed in outmoded and inadequate buildings. During the war years most of the "basics" were expanded to meet the enormous demands for increased production. Such expansions included the most advanced mechanical features, technological ideas, and methods. These plants are adequately supplying our present peacetime requirements. It is a different story in what is called the "fabricating" group This group produced for the war effort by conversion from one product to another and reversed this procedure after the war. There were relatively few new plants built in this group during the war. These were the last word in every respect. They included good lighting, adequate ventilation, air conditioning for processing and comfort. These are scattered throughout the country, and the mere existence of one or more in a community is forcing the replacement and modernization of others in the neighborhood.

At the present time there is a great deal of activity in relocating existing industrial plants. During World War II many of the larger industries began to look favorably upon the idea of "feeder" plants. These are small plants set up in small communities to produce small parts which are shipped to larger assembly plants. This has proved profitable primarily because of labor problems. In smaller communities, particularly in agricultural districts, there is an abundance of cheap labor available during certain seasons. These plants can vary their volume of production during the year to utilize the farmers' spare time, and average out through the year the required quantity of their product to carry the assembly plants through the same period.

Other factors causing the relocation of industrial plants is the threat of the atomic and the hydrogen bomb and basic freight-rate subjects. Many plants will be moved from congested districts to escape possible bombing out in the event of a sneak attack by an aggressor nation. With the present situation as regards freight rates, many manufacturers are planning decentralization and use of many smaller plants scattered throughout the country.

In the immediate ensuing years a large portion of our manufacturing industry must be rehoused in modern and up-to-date buildings. These new plants must and will include every mechanical improvement known to the industry. In fact, the limit of the improvements is almost entirely dependent upon the ability of the mechanical engineer to develop new ideas. His future is in his own hands.

CONSTRUCTION FOR TRANSPORTATION INVOLVES MECHANICAL ENGINEERING

The actual inclusion of mechanical equipment in heavy highway construction is somewhat restricted by the nature of the work. Generally speaking, there is not much that can be offered by the mechanical engineer in the design of the average highway, bridge, or dam. Even so, he is required for highway lighting, and can be of great help in some drainage problems, movable bridges, and tunnels.

We can see the present trend to more and more complex transportation problems in all fields—highway, air, rail, and pipe line. A repetition of the past will continue in the future. When the rail line had to cross a shipway, the mechanical engineer helped the railroad provide a movable bridge. When the highway designer wanted to go under a river or through a mountain, he called on the mechanical engineer. When the air traffic taxed the facilities of the airport, the mechanical engineer relieved the congestion by providing underground fuel lines and turntables for the planes. When natural gas from Oklahoma was needed in Chicago, the mechanical engineer moved it by pipe line. When rail and ships could not give New York City sufficient gasoline at a reasonable price, the mechanical engineer did it with his pipes and pumps. All of these facilities are built by the construction industry, heavy and highway section, and each year this type of project is including more and more features designed by the mechanical engineer. What fantastic idea will be next is not known, but we can be assured that the mechanical engineer will be involved. Possibly it will be the belt-conveyer system extending from the Great Lakes to the Ohio River to move coal in one direction and iron ore in the other.

The amount of mechanical work included in other phases of work done by the heavy and highway subdivision is relatively small in percentage, but not to be overlooked in dollar values. We may expect the dollar value of this work to increase as our population increases, and the American people continue to demand and get more conveniences and pleasures out of life.

Over the past few years we have seen the development of the TVA. The electric power, and the waterway improvement has opened a new section for industrial development. The electric power alone has improved the lives of millions for hundreds of miles. The politicians are discussing similar developments for the Missouri River Valley, and others are mere dreams.

There will be, for many years to come, demands for more irrigation, more electric power, more waterway improvements. These must come to support the continual increase in population and standard of living. The mechanical engineer's share of this type of work will continue to increase, and only his failure to develop improvements will retard this.

RENTAL OF CONSTRUCTION EQUIPMENT

There may be some who would object to including as a part of the construction industry, the business of manufacture, sales, and rental of construction equipment. However, the success of such business is so closely related to the annual volume of construction that its inclusion with the construction industry is not illogical. It is recognized that many items of equipment used by the construction industry are also used in other work. The coal, lumber, shipping, and agricultural industries use many items such as shovels, cranes, graders, various kinds of crawler-type vehicles, and the like, but the portion is small compared to that used by the construction industry. In addition to these larger items, when consideration is given to the multitude of smaller tools used in construction work, it is not unreasonable to include all who participate in the production, sales, or rental of such items, as a part of the construction industry.

The average general constructor, regardless of the classification of work performed, owns those items of tools and equipment that can be kept operating a large percentage of the time. When additional items are needed to properly execute a particular contract, they are usually rented from some equipment-rental firm.

Most cities support one or more equipment-rental firms. These firms own large numbers of various items of contractor's tools and equipment and these are available at standard rental rates to any contractor. This business has expanded by leaps and bounds during the last 20 years. Department of Commerce figures show that $468,000,000 worth of excavating and earth-moving equipment was shipped by manufacturers in

1949. This was about 10 per cent less than 1948, but substantially ahead of 1947. In over-all contracting work, this type of equipment represents approximately 50 per cent of the total of tools and equipment. The balance includes all small tools, trucks, hoists, cranes, and so forth.

Today there are approximately 2500 firms throughout the country engaged in the sales and rental of contractor's tools and equipment. Over 500 of these are members of the Associated Equipment Distributors, an organization which furnishes advisory services, with particular information as to depreciation and maintenance costs, average rental rates, and rental contracts. These firms did a total volume last year of one and a quarter billion dollars. This is equivalent to better than 6 per cent of the 1949 construction volume. As this is reflected in final construction costs, it is within the scope of the mechanical engineer in the construction industry.

The mechanical engineer is almost entirely responsible for the production, sales, rental, and operation of contractor's tools and equipment. He is required in every phase of this work from the young man just out of college and working in the drawing rooms, to the top executive positions. This phase of the construction industry has advanced from obscurity to its present position in 50 years. The volume of this work must continually increase in the future for two reasons. It will increase directly with the predicted increase in construction volume and at the same time a greater proportion of the work now done by hand must be done by machinery.

MATERIALS-HANDLING EQUIPMENT A JOB FOR THE MECHANICAL ENGINEER

In somewhat this same category could be placed the enormous amount of materials-handling equipment required in many industrial plants, warehouses, and commercial structures. These items fall somewhere between "building services" and "plant equipment," but in both cases they either must be included in the construction of the facilities, or provisions must be made in the structure for their later installation. These items range from simple chutes to very elaborate systems of conveyers, rails, tubes, cranes, hoists, etc., for both vertical and horizontal transportation, and many include such items as small pneumatic systems for moving change and sales slips in department stores, or complicated installations for dumping complete railway cars of coal or ore.

MECHANICAL ENGINEERS DESIGN AND PRODUCE BUILDING EQUIPMENT

In the design of the mechanical features of a building or structure, the mechanical engineer is interested in bringing together and assembling a great many finished products into a complete operating system. In order to provide a cooling system for a building, the engineer determines the required performance of the system and then selects the various compressors, exchangers, fans, motors, controls, filters, and other elements on the basis of the characteristics of previously designed items. There may be a number of manufacturers, for example, who produce fans of substantially the same characteristics. Each of these manufacturers requires mechanical engineers in the design and production of its particular product. This situation exists in regard to a majority of the various items brought together to provide the mechanical services in a building. Such items as domestic refrigerators, "package" air conditioners, and many other complete units also are in this category. With this condition existing, we can readily see that the mechanical engineer in the construction industry is supported by thousands of mechanical engineers who are required in industries that could in no way be considered as a part of the construction industry.

There is no way to make a realistic analysis of the various manufacturers of these predesigned items, but a study of billings by the mechanical trade subcontractors to the general contractor shows that 30 per cent of the value of the mechanical features of a building are of this type. This figure will check out very well with the observations of J. P. H. Perry, vice-president of the Turner Construction Company of New York, N. Y., who states[1] that the ratio of architects to engineers involved in the construction of a building is approximately one to ten. An analysis of his figures indicates that five of the ten engineers are concerned with the mechanical features.

We have seen earlier in this article that the mechanical engineer is responsible for approximately 40 per cent of the value of building construction. By bringing in these engineers responsible for what might be called predesigned items, this figure could be increased substantially. This increase cannot be included in the summary figures as it is already included in total construction costs.

SUMMARY

In summarizing it is found that the mechanical engineer, directly employed in the construction industry, along with those designing, selling, and renting tools, equipment, and machinery used in such construction, is responsible for better than 34 per cent of the total of all construction costs. This represents approximately 3 per cent of the national income for 1949. When we realize the rate of increase over the past 50 years it is difficult to guess what these figures will be in another 10 years.

The history of the mechanical engineer in the construction industry has been remarkable. The future can be only a repetition of the past.

[1] "Engineers Play Vital Role in Building Construction," by J. P. H. Perry, *Civil Engineering*, vol. 20, January, 1950, pp. 22–25.

Problems of Leadership

THE public is prone to think that money is what gets things done. Congress passes laws to accomplish objectives, and establishes organizations on paper and appropriates funds to implement these laws. All this is necessary and proper. It gets publicity and the public feels that the job is in hand. If, later, it learns that the job, which its Congressional representatives ordered done and for which it is paying through taxes, is not proceeding satisfactorily, a great hue and cry may be raised. But back of the scenes there may very well have been the failure, in spite of strenuous search, to find the people qualified to get the job done. I have often felt sorry for the head of some governmental agency, even up to the President himself, when he has been criticized for making an ineffective appointment, and when I have known that man after man to whom the job has been offered has refused to take it.

The serious bottlenecks to American accomplishment, whether in public affairs or in private business, are not lack of funds but lack of the proper quality of manpower. There is a profound difference between dollars and men. All dollars, provided they are not counterfeit, are alike and interchangeable; men are not alike and, the more needed, the less are they interchangeable. If the emergency becomes great enough, dollars can be turned out on the printing press or by equivalent means; men cannot be turned out to order, and nature has set a delay period of a couple of decades at least before new people of economic or security usefulness could be made available, even if the order to produce an increased supply went out and were obeyed.—Karl T. Compton, *Electrical Engineering*, March, 1951, p. 193.

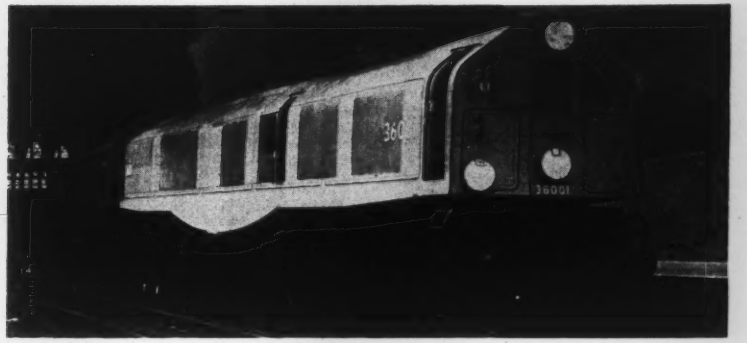


FIG. 1 SIX-CYLINDER STEAM LOCOMOTIVE

PROGRESS *in* RAILWAY MECHANICAL ENGINEERING[1]

1949–1950

THE continued Dieselization of the American railroads again has been the most significant trend in motive-power developments. Between the first of the year and Sept. 1, 1950, the number of Diesel-electric units ordered by domestic railroads totaled 2433. No new orders for steam locomotives were placed with domestic builders for use in the United States during the current year. Several orders for steam locomotives of conventional design were shipped by English and American builders for overseas service, primarily for India. The Norfolk & Western Railway continues its program of steam-locomotive construction in its own shops, and this program is meeting with considerable success from economic and operating standpoints.

Considerable activity in the extension of railroad electrification is evident throughout the railroad world, with the exception of the United States. Many countries have definite plans for electrification with the long-range belief that electric power, whether generated in thermal stations or from hydro sources, will be the most dependable form for their particular economies.

Extensive electrification programs are under way in most European countries including Russia. Most of these countries seem destined to make the change-over from steam to electric operation without the intermediate stage of extensive Diesel electrification, although the Diesel locomotive is being used as an adjunct to electric operation in many cases. The New South Wales Railways system in Australia, while committed to and currently working on electrification, is purchasing new steam motive power as an interim procedure only. In general, those countries which have no domestic fuel-oil resources, or in which oil is economically unavailable, appear to be moving toward electrification as an ultimate form of railroad motive power.

Some of the South American countries, notably Brazil and Chile, are extending existing electrifications and undertaking new ones using equipment manufactured primarily in Great Britain and America.

In the United States the abandonment of electric operation

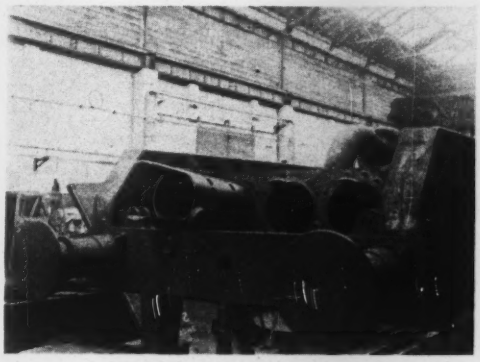


FIG. 2 A THREE-CYLINDER ENGINE USED TO DRIVE LOCOMOTIVE SHOWN IN FIG. 1

[1] Report of Committee RR-6, Survey; Chairman, T. F. Perkinson; members, E. R. Battley, F. A. Benger, R. M. Coultas, R. P. Johnson, and F. L. Murphy.

Contributed by the Railroad Division and presented at the Annual Meeting, New York, N. Y., November 26–December 1, 1950, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

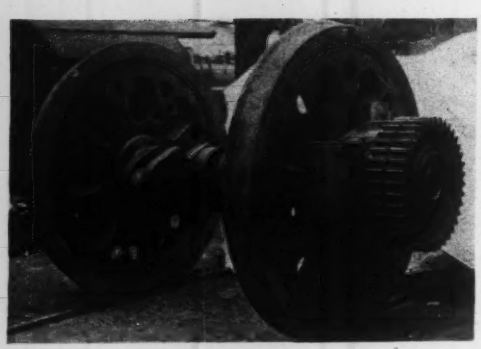


FIG. 3 AN AXLE SHOWING DRIVE CRANKS AND CHAIN GEARS FOR ENGLISH LOCOMOTIVE

FIG. 4 C + C 3000-VOLT D-C LOCOMOTIVE FOR SOUTH AFRICA

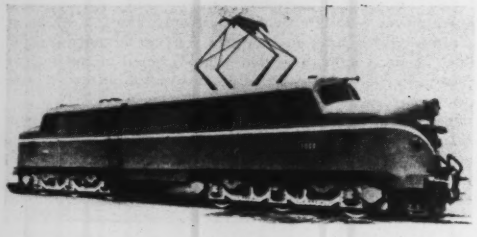


FIG. 5 ENGLISH-BUILT 3000-HP LOCOMOTIVE FOR BRAZIL

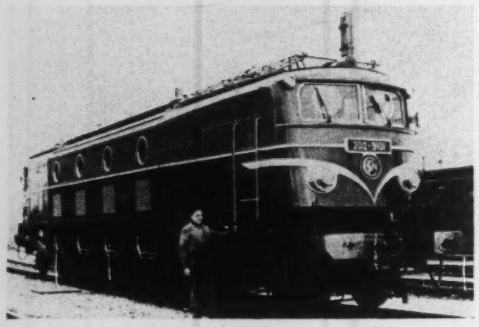


FIG. 6 4400-HP, 1500-VOLT D-C LOCOMOTIVE FOR FRANCE

TABLE 1 STEAM LOCOMOTIVES

Builder	British Railways, Southern Region
Owner	British Railways
Service	Freight and passenger
Cylinder dimensions (6)	12 1/4 in. × 15 in.
Boiler working pressure, psi	280
Driving-wheel diameter, in.	61
Weight per axle, lb	41800
Total locomotive weight, lb	250800
Heating surfaces, sq ft:	
Firebox (incl. syphon)	260
Tubes	1508
Flues	619
Total evaporative	2387
Superheater	454
Total combined	2841
Grate area, sq ft	43
Track gage, in.	56 1/2
Nominal cylinder hp (at 30 mph)	2100
Maximum permissible speed, mph	85
No. of wheels	12
Fuel capacity:	
Coal, tons	4
Water, gal	4000

of a 52.6-mile portion of the Norfolk & Western main line in favor of steam operation has taken place. A major line diversion, with a lesser ruling grade, lesser maximum curvature, and a longer and larger-bore double-track tunnel, has brought about the abandonment of one of the earliest main-line electrifications in this country.

STEAM LOCOMOTIVES

An unusual design of steam locomotive, five of which were placed in trial service on the British Railways beginning the latter part of 1949, is illustrated in Fig. 1. This model incorporates two three-cylinder, sleeve-valve engines, one of which drives each six-wheel truck (Fig. 2). In addition to the enclosure of many moving parts, chain drives have been substituted for coupled driving rods. A driving axle, illustrating both the cranks and the chain gears, is shown in Fig. 3. Further details of this development have been presented before the Society previously.[2] Technical characteristics are shown in Table 1.

ELECTRIC LOCOMOTIVES

Among the electric locomotives built during the year is the one illustrated in Fig. 4. This 2700-hp 3000-volt d-c electric locomotive was built by Metropolitan-Vickers for the South African Railways. Data describing the characteristics of this unit are given in item 1, Table 2.

Another English builder, the Vulcan Foundry, Ltd., has furnished Brazil with fifteen 3000-hp, 3000-volt d-c electric locomotives, one of which is illustrated in Fig. 5. The electrical equipment for these units was built by the English Electric Company. Details are given in item 2, Table 2.

Fig. 6 shows a 4400-hp 1500-volt d-c electric locomotive with a 2-D-2 wheel arrangement built in France for service on the French National Railways. Details are given in item 3, Table 2.

Two new experimental designs of electric locomotives are reported from France. Intended primarily for freight service but used on occasion in passenger service, both designs carry all weight on six axles. Fig. 7 shows the C+C articulated design, while Fig. 8 shows the B-B-B nonarticulated design. Both machines weigh approximately 132 tons and rate in the neighborhood of 3000 hp continuously. The cab structure in the C+C design rests on the truck frames through the usual

[2] "Locomotive and Rolling-Stock Developments in Great Britain," by O. V. S. Bulleid, MECHANICAL ENGINEERING, vol. 72, 1950, pp. 455–461.

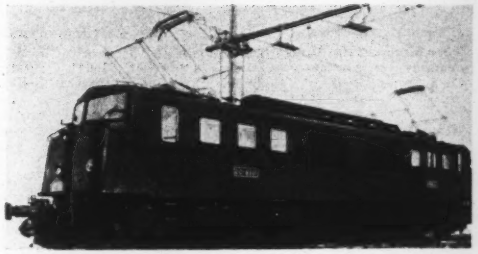


FIG. 7 C + C FRENCH-BUILT LOCOMOTIVE FOR EXPERIMENTAL SERVICE

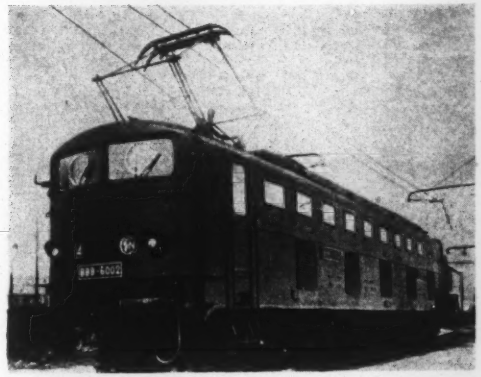


FIG. 8 EXPERIMENTAL B-B-B FRENCH LOCOMOTIVE

center plate with two sprung side bearings, together with a third resilient bearing point which assists in distributing the weight evenly, in spite of the out-of-center position of the center plate occasioned by the use of three-axle all-motored construction.

In the B-B-B design the two end trucks are permitted to move laterally from center under the action of spring-restraint centering devices. The center truck is provided with side bearings only, and the center pin is employed to transmit tractive effort and to provide a point about which the truck can rotate in curvature. Both machines are designed for operation on the standard-gage 1500-volt d-c electrified French National Railways system.

An experimental electrification, utilizing power at an industrial frequency of 50 cycles and 20,000 volts on the contact system without conversion, is being installed on a 48.5-mile light-traffic branch line of the French National Railways between Aix-les-Bains and La Roche-sur-Foron. Two different types of a-c locomotives are being developed for operation on this experimental line. One type employs an a-c/d-c motor generator set and d-c traction motors, the motors being suitable for operation from a 1500-volt contact system which is standard for main-line electrification in France. The second type will use a-c series-wound commutator traction motors. The use of industrial frequency power at high voltage is expected to reduce first costs by eliminating wayside conversion apparatus (motor generator sets, frequency changers, rectifiers) and permitting wide spacing of wayside transformer substations.

TABLE 2 ELECTRIC LOCOMOTIVES

	Item 1	Item 2	Item 3
Railroad	So. African[a]	Brazil[b]	French National
Builder, mechanical	Met. Vickers	English Elec.	French[c]
Builder, electrical	Met. Vickers	English Elec.	French[c]
Wheel arrangement	C + C	C + C	2-D-2
Service	F&P[a]	F&P	F&P
Power supply	3000 v, d-c	3000 v, d-c	1500 v, d-c
Current collector	Pantograph	Pantograph	Pantograph
Driving wheels:			
Number	12	12	8
Diameter, in.	—	48	69
Weight, lb:			
Total	220000	240000	318000
On drivers	220000	240000	202600
Per driving axle	36667	40000	50700
Dimensions, ft-in.			
Length over-all	56-5 1/8	67-3	58-3 3/4
Width over-all	10-0	10-1	—
Height, pantograph down	13-5	14-0	—
Rigid wheel base	14-0	15-9	20-2 1/4
Total wheel base	42-0	50-7	48-2 1/2
Traction motors:			
Number	6	6	4
Method of mounting	Axle-hung	Axle-hung	Rigid
Method of drive	Spur gear	Spur gear	Buchli-link
Gear ratio	17/23	—	—
Tractive force:			
One-hour rating, lb	34000	34300	—
Per cent adhesion	15.45	14.35	—
Continuous rating, lb	26700	26600	—
Per cent adhesion	12.25	11.07	—
Horsepower:			
One-hour rating	2700	3000	4880
Continuous rating	2280	2400	4400
Speed, mph:			
One-hour rating	29.0	32.4	—
Continuous rating	31.5	34.8	—
Maximum speed, mph	60	62	87
Equipped for regeneration	No	Yes	—
Equipped for M.U. operation	Yes	Yes	—
Track gage, in.	42	63	56 1/2

[a] Freight and passenger.
[b] Estrada de Ferro Santos a Jundiai.
[c] Compagnie Electro-Mecanique.

DIESEL LOCOMOTIVES

Fairbanks, Morse & Company introduced its Consolidation line of road locomotives during the year. The "C"-line design essentially brings the advantages of subassembly construction to the railroad shops as subassembly maintenance, by means of the unique design of construction and assembly employed and through the wide range of interchangeability of parts and major components. These advantages are available on a line of locomotives that offers a wide range of horsepower per unit, horsepower per unit of weight on drivers, and total coupled locomotive horsepower. Power-plant ratings of 1600 hp, 2000 hp, or 2400 hp can be installed in one basic structure with no change in general arrangement of the basic unit. The three horsepower ratings can be coupled in various combinations from 1600 hp to 9600 hp in a single locomotive. A two-unit 4800-hp combination is shown in Fig. 9. Details of this locomotive, each unit of which has a B-A1A wheel arrangement, are given in item 1, Table 3. Fig. 10 shows a two-unit 4000-hp locomotive, details of which are given in item 2, Table 3.

General Motors Electro-Motive Division has introduced its GP-7 line of road-switching locomotives. One of these 1500-hp units is illustrated in Fig. 11. Details are given in item 3, Table 3. Along with the development of a new generator, the

TABLE 3 DIESEL LOCOMOTIVES

	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8
Builder	FM[1]	FM	Gen. Motors	Gen. Motors	Gen. Motors	L-H[7]	L-H	L-H
Owner	FM	NYC[5]	Various	Various	Various	PRR[8]	L-H	NKP[9]
Unit wheel arrangement	B-A1A	B-B	B-B	B-B	B-B	C-C	B-B	B-B
No. of units per locomotive	2	2	1	1	1	1	1	1
Total hp per unit (for traction)	2400	2000	1500	1200	800	2500	1200	1200
Service[2]	P	F	RS	S	S	T	RS	S
Engine data (per unit):								
No. of Diesel engines	1	1	1	1	1	2	1	1
Rated hp (per engine)	2400	2000	1500	1200	800	1250	1200	1200
No. of cylinders (per engine)	12[3]	10[3]	16[6]	12[6]	8[6]	8	8	8
Bore and stroke, in	8 1/2 × 10	8 1/2 × 10	8 1/2 × 10	8 1/2 × 10	8 1/2 × 10	9 × 12	9 × 12	9 × 12
Speed (rpm)	850	850	800	800	800	950	950	950
Cycles	2	2	2	2	2	4	4	4
Supercharged	No	No	No	No	No	Yes	Yes	Yes
Manufacturer	FM	FM	Gen. Motors	Gen. Motors	Gen. Motors	L-H	L-H	L-H
Unit data:								
Length over-all, ft-in	56-6	56-6	55-11	44-5	44-5	79-0	57-0	47-10
Rigid wheel base, ft-in	9-4[4]	9-4	9-0	8-0	8-0	13-0	9-10	8-0
Total wheel base, ft-in	43-5	43-4	40-0	30-0	30-0	61-3	40-10	32-6
Weight on drivers, lb	234000	246000	237000	248000	230000	360000	250000	250000
Total weight, lb	286000	246000	237000	248000	230000	360000	250000	250000
Fuel capacity, gal	1200	1200	800	600	600	1250	800	600
Driver diameter, in	42	42	40	40	40	42	40	40
Maximum permissible speed, mph	110	70	88	65	50	65	60	60
Track gage, in	56 1/2	56 1/2	56 1/2	56 1/2	56 1/2	56 1/2	56 1/2	56 1/2

use of silicone-insulated traction motors and a new higher-capacity cooling system, the ratings of the switcher line of locomotives have been increased. Fig. 12 illustrates one of the 1200-hp switchers, and details are given in item 4, Table 3. The 800-hp switcher, shown in Fig. 13, is described in item 5, Table 3.

Since the introduction of its first line of Diesel-electrics reported upon last year, Lima-Hamilton Corporation has built several new types for service on American railroads. Fig. 14, item 6, Table 3, illustrates and describes a 2500-hp transfer locomotive built for the Pennsylvania Railroad. A 1200-hp road switcher is shown in Fig. 15, and details are given in item 7, Table 3. A 1200-hp switcher for the Nickel Plate is shown in Fig. 16 and described in item 8, Table 3. Fig. 17 shows a 108-ton 750-hp switcher, the details of which are given in item 9, Table 3.

American Locomotive-General Electric Companies have delivered redesigned locomotives of increased horsepower ratings. Fig. 18 illustrates a 2250-hp passenger unit. Details are given in item 10, Table 3. A 4800-hp freight locomotive is shown in Fig. 19, and a 1600-hp road switcher is pictured in Fig. 20. Characteristics of these locomotives are given in items 11 and 12, Table 3, respectively.

Item 13, Table 3, describes a 1000-hp switcher furnished the Rock Island Railroad during the year by the Davenport-Besler Corporation. This locomotive is powered by two 500-hp, V-12 Caterpillar engines.

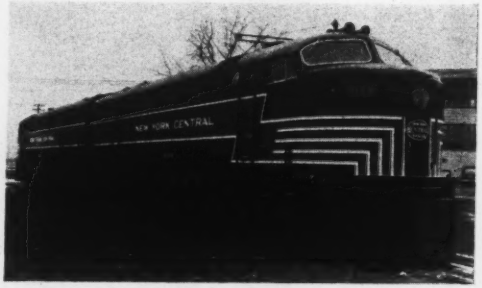


FIG. 10 4000-HP "C LINE" FREIGHT LOCOMOTIVE

Fig. 21 shows a 31-ton 24 1/2-in-gage locomotive built by the same company for service in the Belgian Congo. Characteristics are given in item 14, Table 3.

The Vulcan Foundry, Ltd., has furnished to the Tasmanian Government Railways twenty 660-hp Diesel-electric loco-

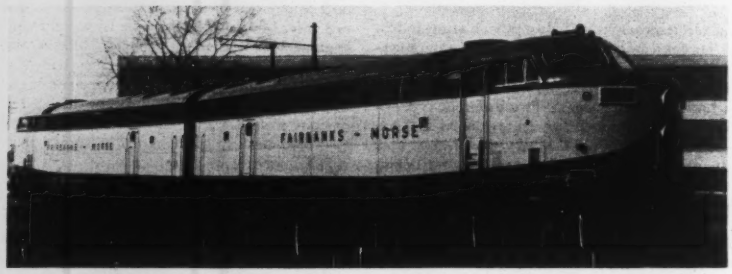


FIG. 9 FAIRBANKS-MORSE 4800-HP "C LINE" PASSENGER LOCOMOTIVE

TABLE 3 (*continued*)

Item 9	Item 10	Item 11	Item 12	Item 13	Item 14	Item 15	Item 16	Item 17	Item 18	Item 19
L-H	Alco-GE[11]	Alco-GE	Alco-GE	D-B[12]	D-B	English[16]	B-W[18]	B-W	B-W	GE[19]
CUT[10]	NYC[8]	Mo. Pac.	Lackawanna	RI[13]	BC[15]	Note[17]	Various	Various	Various	Note[20]
B-B	A1A-A1A	B-B	B-B	B-B	B-B	B-B	B-B	B-B	B-B	C + B + C
1	1	3	1	1	1	1	1	1	1	1
750	2250	1600	1600	1000	295	660	1600	1200	1200	1200
S	P	F	RS	RS	RS	P & F	RS	RS	S	F
1	1	1	1	2	1	1	1	1	1	1
750	2250	1600	1600	500	295	660	1600	1200	1200	1200
6	16[6]	12[6]	12[8]	12[6]	6	—	8	6	6	12[8]
9 × 12	9 × 10½	9 × 10½	9 × 10½	5¾ × 8	6¾ × 8¾	—	12¾ × 15½	12¾ × 15½	12¾ × 15½	9 × 10½
950	1000	1000	1000	1200	1000	—	625	625	625	1000
4	4	4	4	4	4	—	4	4	4	4
	Yes	Yes	Yes			—	Yes	Yes	Yes	Yes
L-H	Alco	Alco	Alco	Cat.[14]	Buda	—	Baldwin	Baldwin	Baldwin	Alco
47-10	66-2	52-0	55-11¾	45-6	26-0	36-8	58-0	58-0	46-0	56-10
8-0	15-6	9-4	9-4	8-0	6-6	8-3	9-10	9-10	8-0	11-6[21]
32-6	49-8	36-6	39-4	30-0	20-6	24-9	42-1	42-1	30-8	46-6
216000	202000	240000	240000	220000	62000	120600	236000	224000	240000	249600
216000	303000	240000	240000	220000	62000	120600	236000	240000	240000	249600
600	1200	1200	800	675	200	340	900	900	650	800
40	40	40	40	40	30	36½	42	42	40	33
60	117	75	75	60	23.5	55	65	60	60	40
56½	56½	56½	56½	56½	24¼	42	56½	56½	56½	36

NOTES:

[1] Fairbanks, Morse & Company.
[2] P, passenger; F, freight; S, switching; RS, road switching; T, transfer.
[3] Opposed pistons.
[4] Rear truck (3-axle) wheel base: 15 ft 6 in.
[5] New York Central Railroad.
[6] V-type engine
[7] Lima-Hamilton Corp.
[8] Pennsylvania Railroad.
[9] New York, Chicago & St. Louis Railroad
[10] Cincinnati Union Terminal Company.
[11] American Locomotive—General Electric Companies.
[12] Davenport Besler Corp.
[13] Chicago, Rock Island & Pacific Railroad.
[14] Caterpillar Tractor Company.
[15] Belgian Congo Lines.
[16] Vulcan Foundry, Ltd. & English Company
[17] Tasmanian Government Railways.
[18] Baldwin Locomotive Works—Westinghouse Electric Corporation.
[19] General Electric Company.
[20] Cia Agricola de Guatemala.
[21] Rigid wheel base of center truck: 6 ft 10 in.

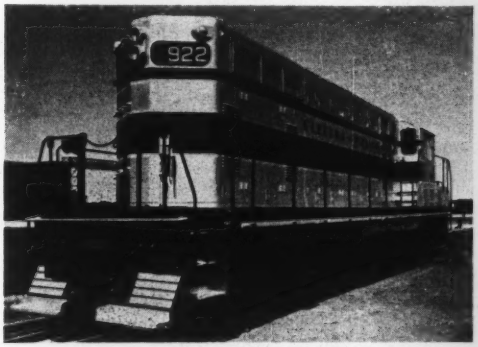


FIG. 11 GENERAL MOTORS 1500-HP ROAD SWITCHER

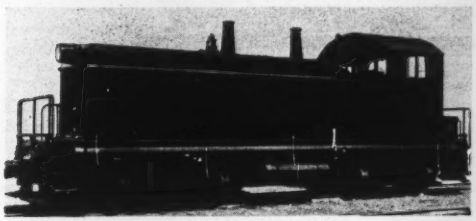


FIG. 12 1200-HP DIESEL-ELECTRIC SWITCHER

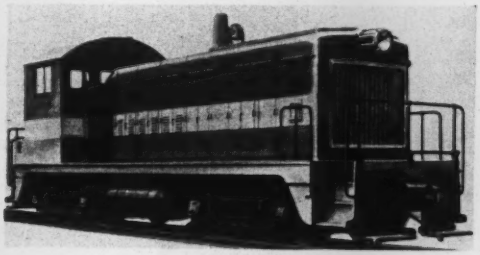


FIG. 13 GENERAL MOTORS 800-HP SWITCHER

motives. Illustrated in Fig. 22, the electrical equipment for these units was built by the English Electric Company. Details are given in item 15, Table 3.

Horsepower ratings have been increased throughout the entire line of Baldwin-Westinghouse locomotives. In addition, several new lines of switchers have been built. Fig. 23 shows a 1600-hp four-axle road switcher, and the details for this are given in item 16, Table 3. A 1200-hp road switcher is illustrated in Fig. 24 and described in item 17, Table 3. In addition, the 1200-hp switcher shown in Fig. 25 has been introduced. Data shown in item 18, Table 3, describe this unit. The 800-hp switchers possess similar characteristics except for the lower ratings occasioned by the fact that the engine is not supercharged.

The General Electric Company has shipped an order of 120-ton, 1200-hp, narrow-gage locomotives to Guatemala. Fig. 26 illustrates one of these units which features an unusual running

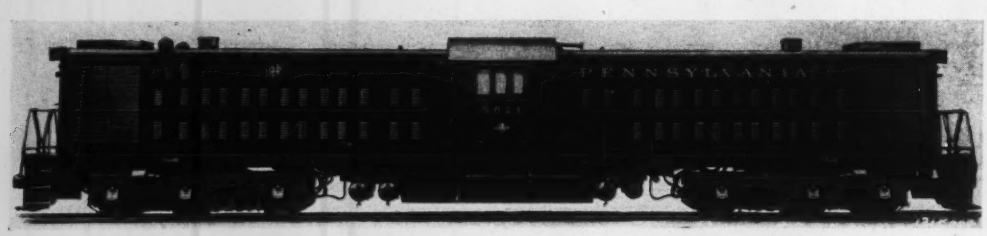


FIG. 14 2500-HP HEAVY-DUTY ROAD SWITCHER

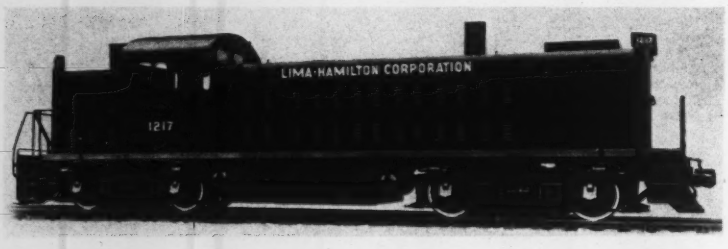


FIG. 15 LIMA-HAMILTON 1200-HP ROAD SWITCHER

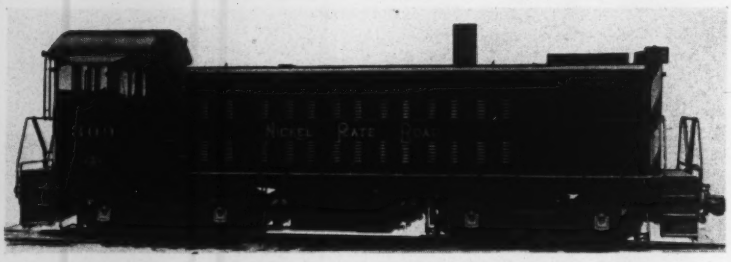


FIG. 16 1200-HP SWITCHER BUILT BY LIMA-HAMILTON

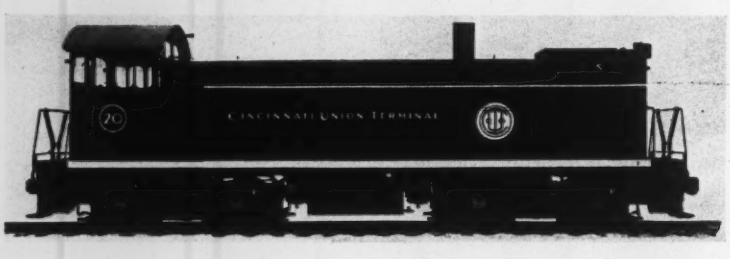


FIG. 17 750-HP, 108-TON DIESEL-ELECTRIC SWITCHER

gear—a C + B + C arrangement. The end trucks are equipped with draft gear at the outer end and an articulation ball joint at the inner end. This ball carries buffing loads and transfers weight to the middle truck. The center truck has a pocket at each end to carry the ball of the end trucks. There is no center plate on this truck as all the weight is applied through the articulation assembly. The articulated joints are immersed in oil and sealed against dirt. Characteristics are shown in item 19, Table 3.

A Diesel locomotive with mechanical transmission (fluid coupling and gear-change box) which utilizes running-gear construction reminiscent of steam-locomotive practice is shown in Fig. 27. A 500-hp, 1250-rpm engine is employed. The locomotive weighs 55.5 tons and has a maximum tractive effort

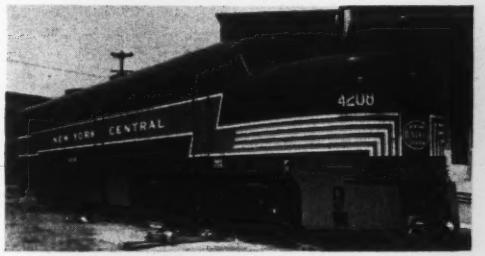


FIG. 18 ALCO-GE 2250-HP PASSENGER UNIT

FIG. 20 ALCO-GE 1600-HP ROAD SWITCHER

FIG. 19 4800-HP FREIGHT LOCOMOTIVE

FIG. 21 $24^1/_2$-IN-GAGE DIESEL-ELECTRIC UNIT

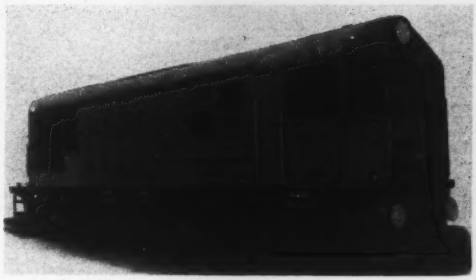


FIG. 22 ENGLISH-BUILT 660-HP LOCOMOTIVE FOR TASMANIA

of 33,500 lb, corresponding to 30 per cent adhesion. A self-shifting clutch for the lower speed ratios and an air-operated clutch for the high ratios, in combination with, in effect, a six-speed gear set, provide a six-step speed range from 5 to 36 mph at full engine speed.

GAS-TURBINE LOCOMOTIVES

Two new gas-turbine electric locomotives were placed in experimental running service during the past year, bringing the total number of this type of motive power in actual running service throughout the world to four.[3]

Fig. 28 is illustrative of the 4000-hp unit[4] built by Westinghouse Electric Corporation, and leading dimensional data are given in Table 4. This is the only gas-turbine locomotive built so far to employ a double power plant. The mechanical portion of the locomotive incorporates an unusual method of cab-weight distribution over the four identical trucks, in that no span bolsters between trucks are employed. The cab is carried directly on the truck frames, and weight distribution is accomplished by the use of relatively "soft" coil and semielliptic springs. The locomotive is equipped with two train-heating boilers, one of which is a conventional oil-fired unit while the other utilizes waste heat from the exhaust of one of the gas-turbine sets.

The 2500-hp gas-turbine electric locomotive built in Switzerland by Brown Boveri and Swiss Locomotive Works for the British Railways is illustrated in Fig. 29, and salient data are given in Table 4. In so far as the power plant is concerned, this unit is quite similar to the 2200-hp locomotive[5] built by the same company for the Swiss Federal Railway in 1941. The running gear, however, is quite different and embodies, in an A1A-A1A wheel sequence, a novel arrangement for carrying the cab on the two trucks. A cutaway drawing of the truck,

[3] In addition to the two described in the present report, the Alco-GE unit, described in the 1948–1949 report of this Committee, and the Brown Boveri 2200-hp unit operating on the Swiss Federal Railways, are in current service.

[4] "A 4000-Hp Gas-Turbine Locomotive for Passenger Service," by W. A. Brecht, C. Kerr, Jr., and T. J. Putz, presented at the Annual Meeting, November 27–December 2, 1949, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[5] "Gas-Turbine Locomotive With Electrical Transmission," by P. R. Sidler, MECHANICAL ENGINEERING, vol. 65, 1943, pp. 261–264.

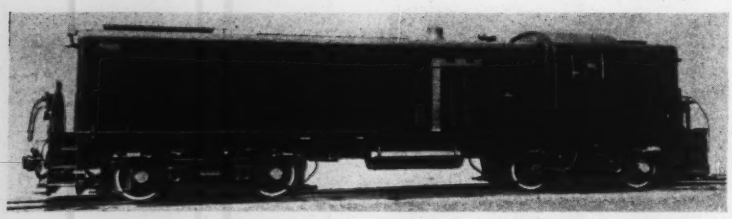


FIG. 23 BALDWIN-WESTINGHOUSE 1600-HP ROAD SWITCHER

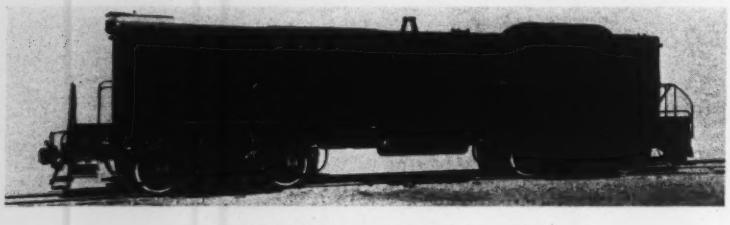


FIG. 24 1200-HP DIESEL-ELECTRIC ROAD SWITCHER

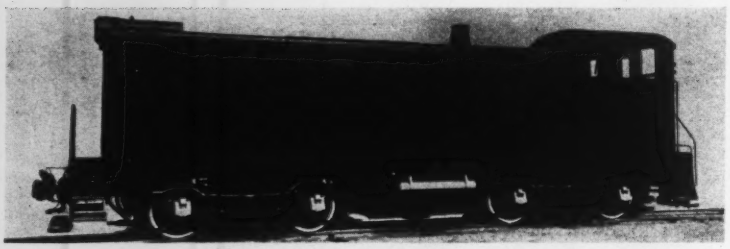


FIG. 25 BALDWIN-WESTINGHOUSE 1200-HP SWITCHER

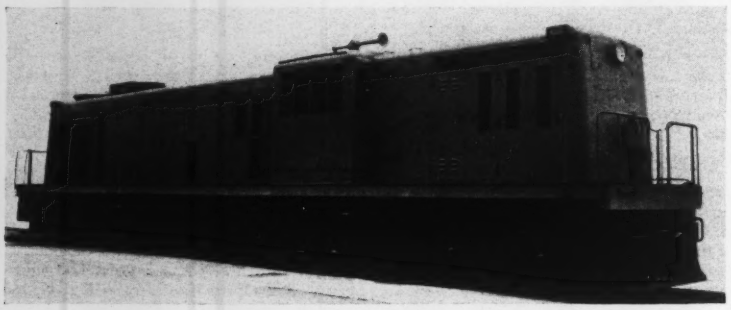


FIG. 26 36-IN-GAGE LOCOMOTIVE FOR GUATEMALA

showing the method employed for cab centering and support, is shown in Fig. 30. The traction motors are nose-suspended and quill-mounted, driving through coiled transmission springs in the gear assembly. This construction, indicative of general European trends where large nose-suspended traction motors are employed, contrasts sharply with American practice, which adheres largely to the solid gear and axle-suspension system.

The 4500-hp Alco-GE gas-turbine locomotive, described in the 1948-1949 report of this committee, has been in continuous service on the Union Pacific System since mid-1949, except for

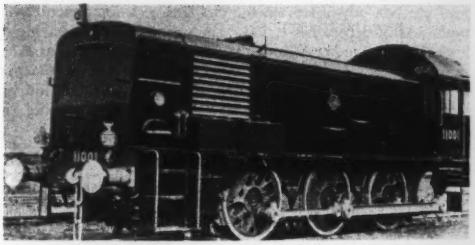


FIG. 27 MECHANICAL-DRIVE DIESEL SWITCHER FOR GREAT BRITAIN

FIG. 28 WESTINGHOUSE GAS-TURBINE ELECTRIC LOCOMOTIVE

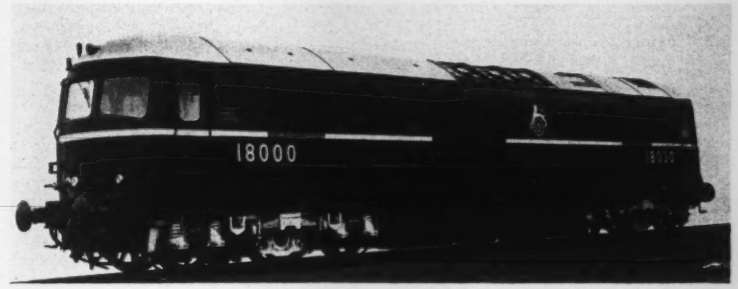
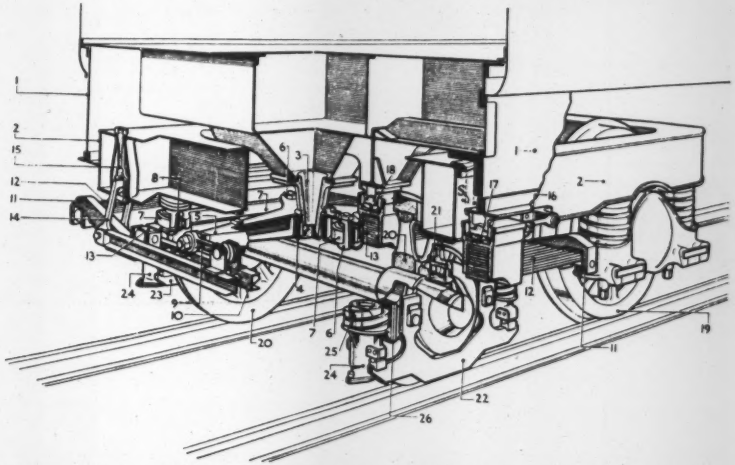


FIG. 29 BROWN BOVERI GAS-TURBINE ELECTRIC LOCOMOTIVE



1. Underframe of body 2. Bogie frame 3. Centre pivot 4. Silentbloc of centre pivot bearing 5. Cross-head transmitting the tractive effort and holding the swing bolster transverse beam 6. Link pin for the drawbar with Silentbloc bearing 7. Drawbar transmitting the tractive effort 8. Link pin fixed on the bogie frame with Silentbloc bearing 9. Connecting link for the swing bolster transverse beam with Silentbloc bearings 10. Transverse beam for the swing bolster 11. Cross equalising beam for the body suspension springs 12. Outer body suspension spring 13. Inner body suspension spring 14. Spring hangers 15. Spring hanger regulating screw 16. Longitudinal connecting link for the body suspension spring 17. Outer body side bearing with oil trough 18. Inner body side bearing with oil trough 19. Driving wheel 20. Carrying wheel 21. Axlebox with self-aligning roller bearing 22. Outer hanger for carrying axlebox 23. Inner hanger for carrying axlebox 24. Axlebox guide with spring seat 25. Helical spring 26. Thrust faces S. Lateral play between bogie and body

FIG. 30 TRUCK FOR LOCOMOTIVE ILLUSTRATED IN FIG. 29

TABLE 4 GAS-TURBINE LOCOMOTIVES

Builder	Westinghouse	Note (1)
Owner	Westinghouse	British Railways
Wheel arrangement	B-B-B-B	A1A-A1A
Service	Passenger	Passenger
Weight on drivers, lb	488000	174000
Total weight, lb	488000	258000
Length over-all, ft-in	77–10	63–0
Fuel	Heavy oil	Heavy oil
Fuel capacity, lb	12000 (est)	38000
Driving-wheel diam, in	42	48 1/2
Type of drive	Electric	Electric
Gage, in	56 1/2	56 1/2
Maximum speed, mph	100	90
Turbine data:		
Number	2	1
Horsepower	2000 (each)	2500
Speed, rpm	8750	5800
Manufacturer	Westinghouse	Note (1)

NOTE (1): Turbine and electrical equipment built by Brown Boveri, mechanical portion by Swiss Locomotive & Machine Works.

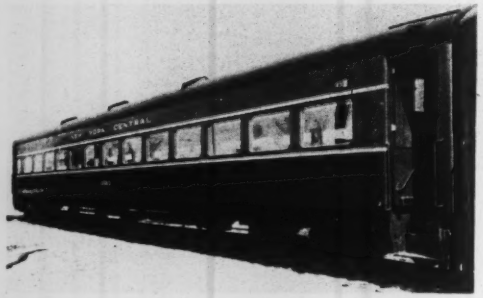


FIG. 31 NEW YORK CENTRAL ELECTRICALLY DRIVEN COMMUTER CAR

brief periods out-of-service for changes and component overhaul. As of September 1, 1950, the power plant, operating on heavy fuel oil, had been run a total of 3656 hours with outstanding success considering the nature of the unit as a developmental project. A total of 55,045 miles of locomotive operation has been accumulated in revenue freight-train service during the same period.

STEAM-TURBINE LOCOMOTIVES

The Pennsylvania Railroad S-2 direct-drive steam-turbine locomotive[6] has been set aside due to maintenance difficulties. The Dieselization of this railroad has led to the decision to abandon the development of this type of power for the present.

The Norfolk & Western Railway has placed an order for a new-type coal-burning steam-electric locomotive to be built by Baldwin Locomotive Works. Projected for freight service, this unit is designed to develop 4500 hp. A water-tube boiler producing steam at 600 psi will be used. Steam from the boiler will drive an impulse-type turbine which will operate a two-unit direct-current generator through a set of single-reduction gears. A motor will be mounted on each of the 12 axles. The locomotive is designed to have some of the desirable characteristics inherent in locomotives with electric drive, e.g., high starting tractive effort and relatively light axle loading. The locomotive will have a B-D-B-D wheel arrangement and a separate water tender of 16,000 gal capacity. The locomotive weight, including tender, will be about 952,000 lb, and the over-all length will be approximately 148 ft; 20 tons of coal will be carried in the nose ahead of the operator's cab. Babcock & Wilcox will build the boiler, and Westinghouse will furnish all electrical equipment.

PROJECTED MOTIVE-POWER DEVELOPMENTS

The two experimental electric locomotives, reported last

[6] "Progress in Railway Mechanical Engineering, 1944–1945," MECHANICAL ENGINEERING, vol. 68, 1946, pp. 107–122.
"Progress in Railway Mechanical Engineering, 1947–1948," MECHANICAL ENGINEERING, vol. 71, 1949, pp. 299–315.

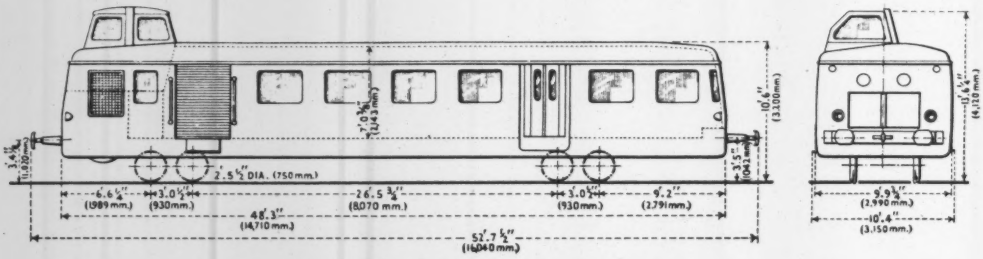


FIG. 32 MECHANICAL-DRIVE DIESEL RAIL CAR FOR FRANCE

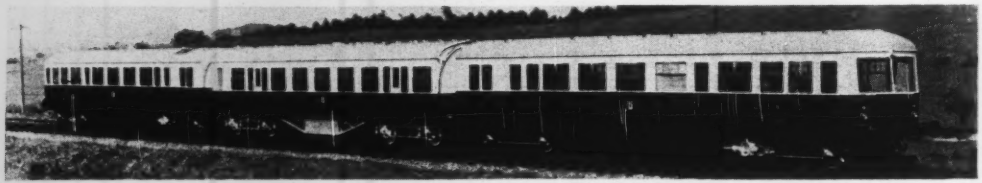


FIG. 33 63-IN-GAGE, HIGH-SPEED, DIESEL-MECHANICAL RAIL CARS

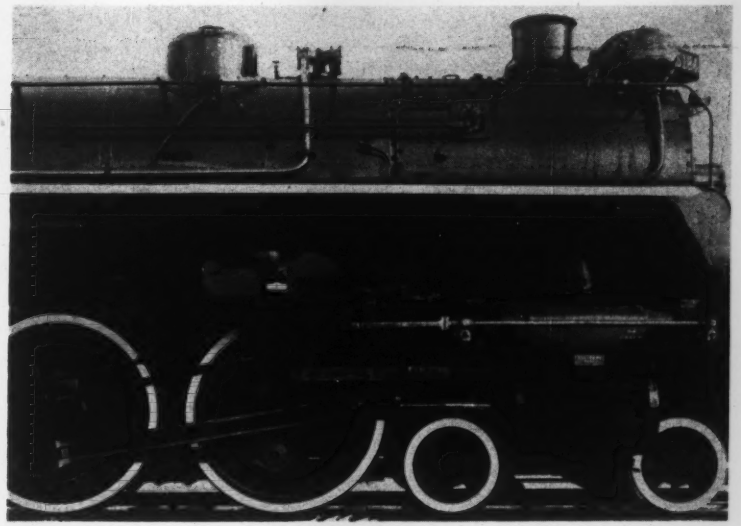


FIG. 34 POPPET VALVE AND DRIVING GEAR ON CANADIAN NATIONAL LOCOMOTIVE

year as being under construction by Baldwin-Westinghouse for the Pennsylvania Railroad, and originally designed to include a-c series commutator traction motors, are now projected to employ d-c traction motors to be fed by ignitron rectifiers carried in the locomotive. Interest in the rectifier locomotive is occasioned not only by economies which might result, but also from the fact that this broadens the possibilities for utilization of electric power at commercial frequencies (such as 60 cycles) on the contact systems of new electrifications.

RAIL CARS

The first several of 100 new suburban cars, being built for the New York Central Railroad by the St. Louis Car Company and equipped with General Electric electrical apparatus, were delivered during the year. These cars, one of which is illustrated in Fig. 31, were designed to operate in multiples of from two to fifteen cars per train on the existing 600-volt d-c third-rail system in the New York City area. Each car has four truck-mounted traction motors and is 85 ft long and 10 ft 4 in. wide. The extra 4 in. of width were secured by recessing the grab irons at the vestibule ends. The greater inside width of the car and the resulting seating arrangement, where three people are seated on one side of the aisle and two passengers on the other side, gives a total seating capacity of 130 passengers. These cars are equipped with air conditioning, automatic heating control, fluorescent lighting, and extra-wide luggage racks.

Unusual, from the American point of view, are the lightweight Diesel mechanical-drive rail cars built in France for the SNCF (French National Railways). One of the unusual features is the conning tower, which contains the operator's position, rising above the car roof and offset as shown in the diagram, Fig. 32. The operator sits facing sideways, enabling him to see in either direction with equal facility over the roof. A periscope is provided to enable the driver to observe cars during coupling and switching operations. A four-axle running gear in a rigid wheel base is provided. The two outside axles in each two-axle truck assembly are provided with 0.87 in. of lateral, while the inside axles are without lateral. Drive is from a transversely mounted 150-hp Diesel engine through a clutch gear assembly to the inside axle in the forward truck assembly. Top speed is limited to 59 mph.

Twenty Diesel rail cars are being placed in service on the Great Northern Railway (Ireland) replacing steam trains in both main and branch-line service. Although they can be used as single rail cars, the intention is to run them in trains of three cars, consisting of two power cars and one passenger car as illustrated in Fig. 33. Having a maximum speed of 70 mph, these cars will operate on 5 ft 3 in. railway gage. Each power car is propelled by a 125-hp Diesel engine. The drive from the engine is transmitted through a fluid flywheel and universally jointed shaft to a countershaft and then to a five-speed preselective-type epicyclic-gear box by another shaft. The final drive to the axle is of the double-reduction type.

MISCELLANEOUS DEVELOPMENTS

While Diesel-powered locomotive cranes are by no means new developments, the fact that the Western Maryland has recently converted a steam-powered 50-ton crane to Diesel power with hydraulic drive is worthy of note. Two 147-hp, 1350-rpm two-cycle Diesels, driving through a hydraulic torque converter, supply propelling and lifting energy, while a self-contained 20-kw Diesel generator set furnishes energy for a 66-in. lifting magnet. Power for lighting, control, and battery charging is supplied from a small 32-volt 900-watt generator driven from the main-engine assembly. Considerable reduction in operating costs and increased availability, reliability, and efficiency of operation are reported in favor of the converted crane.

A new design of poppet valve and driving gear, applicable to existing steam locomotives without the necessity of replacing the cylinder casting, has been tried out in experimental service on a Canadian National locomotive shown in Fig. 34. The gear consists of the following:

(*a*) A primary drive mechanism which transmits properly

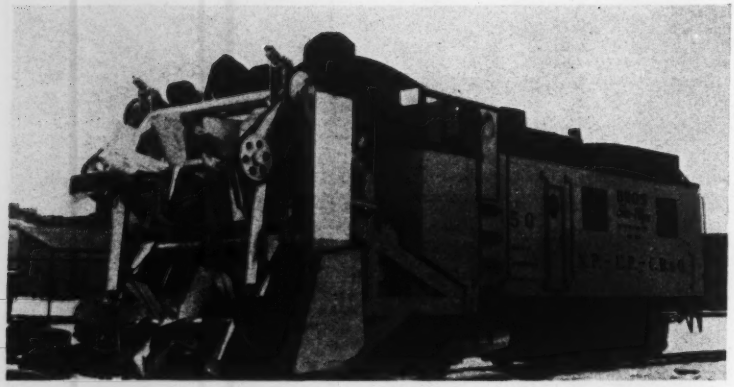


FIG. 35 BROS SNOWPLOW WITH WINGS RETRACTED AND RAKES LOWERED

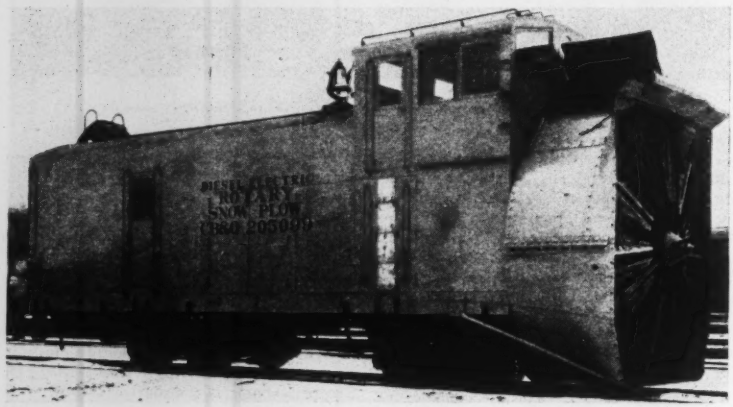


FIG. 36 DIESEL-ELECTRIC ROTARY SNOWPLOW

synchronized rotary movement from the main crankpin to the camshaft drive mechanism, located in the position formerly occupied by the conventional piston valve gear replaced.

(*b*) A camshaft drive which transforms the rotary movement derived from the primary mechanism into a rocking movement of the two rocker arms located on the valve-insert housings at each end of the valve chamber.

(*c*) Steam-valve-chest inserts, located at each end of the existing valve chambers. Each of these inserts carries one inlet poppet valve and two exhaust poppet valves with suitable actuating gear.

A minimum of changes are required to install the equipment on existing locomotives, the principal change being the reboring of the steam valve chests to accept the poppet-valve inserts. The experimental installation was manufactured by the Dominion Engineering Works of Montreal under Singmaster and Breyer designs.

Three new types of snowplow have been placed in service by American railroads during the year. Fig. 35 illustrates an experimental rotary snowplow of new design built by the Wm. Bros Boiler & Manufacturing Company for joint use of the Northern Pacific, Union Pacific, and Burlington railroads. The plow is powered by a General Motors Electro-Motive Diesel engine developing 1080 hp at 750 rpm. The plow differs from conventional machines in that there are two sets of rotors, each of which has four cup-shaped blades which convey the snow upward. One pair of rotors is located above the other. In front of each set of rotors is a rake which rotates at about one fourth the rotor speed. This action breaks up the snow prior to reaching the rotors.

Fig. 36 illustrates an electric rotary snowplow designed for use in connection with Diesel-electric locomotives. Being 36 feet long and weighing 91 tons, this plow was built in the company shops of the Burlington Railroad. It utilizes the underframe, trucks, rotor and rotor chute of an old steam-driven plow. The rotors are driven by four motors (Diesel-electric locomotive traction motors) which take power from the first unit of a four-unit freight locomotive normally used as a pusher, the traction motors of the first unit being disconnected.

FIG. 37 LIMA-HAMILTON STEAM-DRIVEN RAILWAY SNOWPLOW

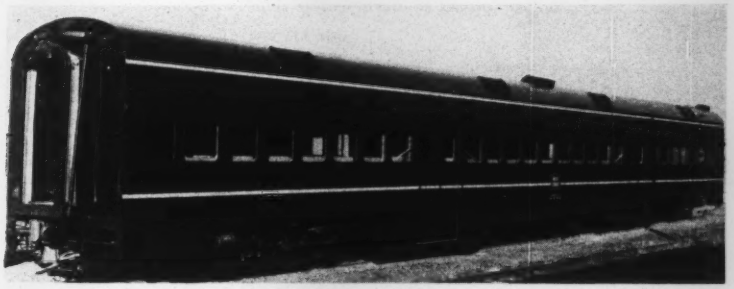


FIG. 38 SUBURBAN CAR FOR ROCK ISLAND COMMUTER SERVICE

Lima-Hamilton has delivered to several railroads a new design of steam-powered, oil-burning snowplow. These 297,000-lb units, one of which is shown in Fig. 37, develop 1500 hp each. Two three-cylinder engines, geared to a common shaft, are employed for rotor drive.

PASSENGER CARS

New passenger cars totaling 513 were completed in the first half of 1950, and placed in service by the railroads. At that time there was a backlog of 554 passenger cars on order, including 44 being built in railroad shops. Practically all of these cars were completed in 1950.

During the year a large number of new passenger cars and trains have been placed in service. Representative of the new trains are the Budd-built Wabash *Bluebird* operating between Chicago and St. Louis, a stainless-steel train of 6 cars including 4 dome cars; the Norfolk and Western *Powhatan Arrow* built by Pullman-Standard; the *International* and *Red River* trains for the Great Northern built by American Car & Foundry; the Southern Pacific *Sunset Limited*, and San Francisco-Portland trains built by Pullman and Budd. These trains, as well as many others, include the latest developments in passenger-car design, construction, and appointments for passenger comfort.

Pullman-Standard delivered twenty new suburban cars to the Rock Island. The exterior of one of these cars is shown in Fig. 38. One of the main features of these cars is the step, and floor and door arrangements, all of which have been designed to attain maximum speed and ease of loading and unloading as well as safety. Two double entrance doors are located between the trucks of each car. Sliding doors, mechanically operated, at the side of the car provide fast opening and maximum safety as they are closed at all times the train is in motion. Three wide steps allow fast safe loading or unloading to the floor in the main body of the car, which is $7^1/_2$ in. below conventional floor level. Twelve of these cars are air-conditioned. Eight have a forced-draft ventilating system designed to hold the inside temperature at the level of the outside tempera-

FIG. 39 WASHSTAND ARRANGEMENT IN PULLMAN-BUILT SLEEPING CARS

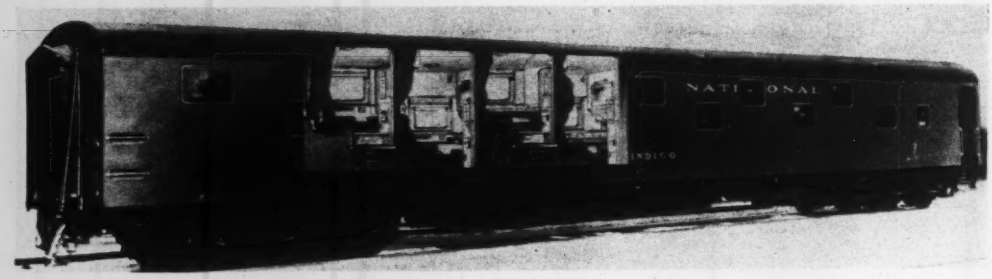


FIG. 40 - DUPLEX ROOMETTE SLEEPER BUILT IN CANADA

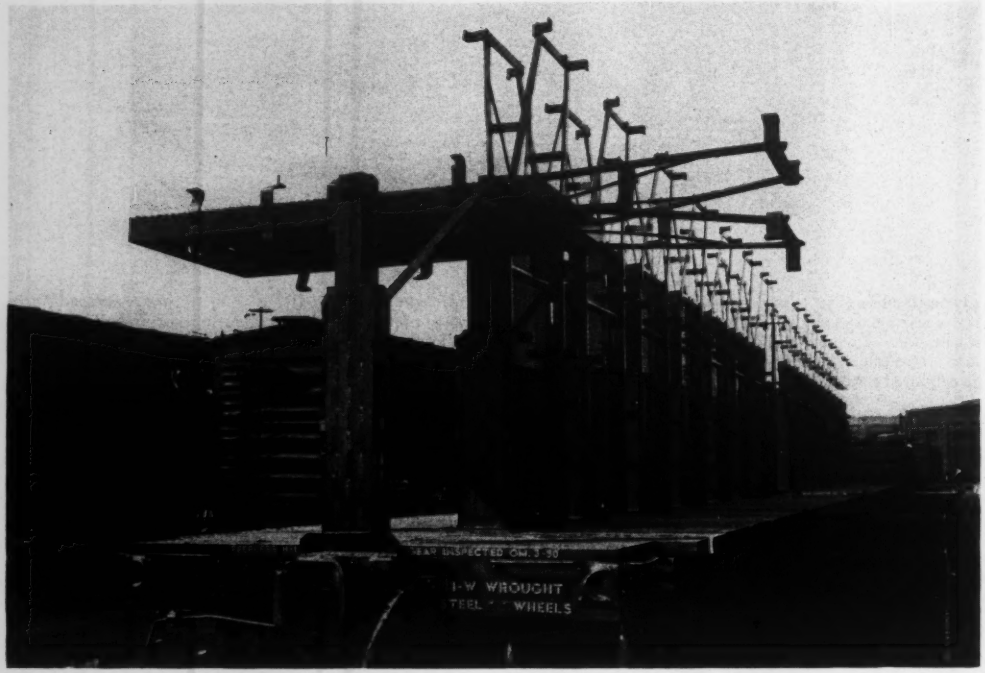


FIG. 41 FLATCAR DESIGNED TO HAUL AUTOMOBILE BODIES

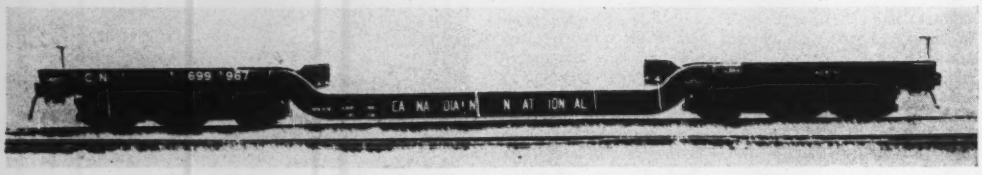


FIG. 42 DEPRESSED-CENTER FLATCAR FOR CANADA

ture with windows closed. A maximum of 12,000 cfm of filtered outside air is circulated in the car. All cars have fluorescent lighting.

During the year, Pullman-Standard delivered to the Chesapeake & Ohio and Nickel Plate Railroads the first of an order of sleeping cars incorporating new features in both bedrooms and roomettes. The bedrooms are arranged in pairs with crosswise folding upper and lower berths and two folding lounge chairs for daytime use. The berths are adjacent to the transverse sliding partitions between rooms which, when opened, provide large square rooms for daytime use and twin lower and upper beds at night. The hoppers are in separate annexes. In each bedroom the novel washstand is located in a recess between toilet rooms. Fig. 39 shows the washstand arrangement. In each roomette the folding-type washbasin has been replaced by a fixed washstand located in one corner. A cutout in the foot of the bed provides clearance for the bed to pass by the washstand when folded down. This cutout also gives space for the occupant to stand or to use the washstand when the sliding door is closed and the bed folded down.

During the year the Canadian Car & Foundry, Ltd., furnished the Canadian National Railways 20 duplex roomette cars. Fig. 40 illustrates one of these modern sleeping cars.

FREIGHT CARS

For the past year the production rate of freight cars has been extremely low, but the Korean War has brought to the forefront the imperative need of additional freight equipment, and the necessity for a planned replacement of obsolete and worn-out freight cars. In July, 1950, the directors of the Association of American Railroads proposed a program calling on the railroads to build 10,000 freight cars a month during the next year. This request has resulted in a large number of freight-car orders, and indications are that the AAR program will be carried through.

The trend toward standardized freight cars, or the so-called "package" car, which was started three years ago is increasing. The number of types of standard cars being offered is increasing each year.

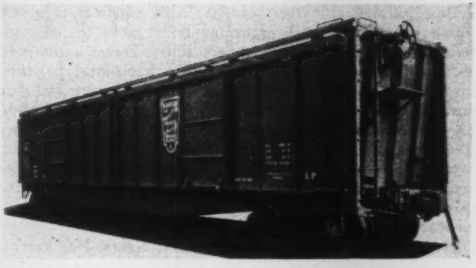


FIG. 43 PULPWOOD CAR FOR BANGOR & AROOSTOOK

FIG. 44 CANADIAN PACIFIC-BUILT ALUMINUM BOXCAR FOR ROBERVAL & SAGUENAY

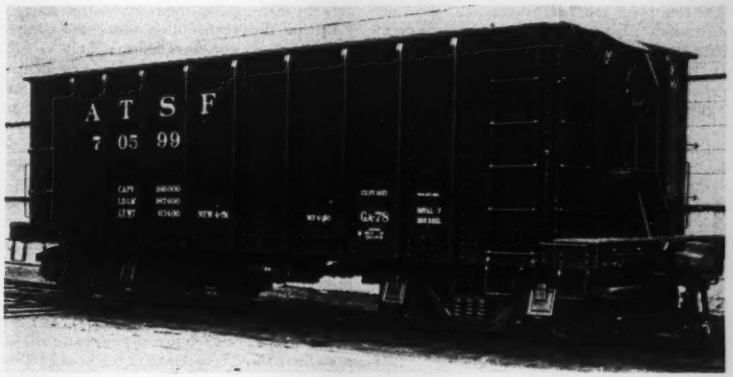


FIG. 45 95-TON-CAPACITY COPPER-ORE CAR

Freight-car developments during the past year show three specific trends:

1 The increasing demand for specialized types of cars, or features within cars developed to carry a specific lading with the maximum over-all economy and convenience to shipper, consumer, and railroad. Special emphasis has been given to reduction in handling costs.

2 Further development of loading devices and means of blocking or anchoring lading to increase revenue loads and to protect the lading against damage en route.

3 The development of improved components, such as flooring in cars; these developments in many instances being associated with items 1 and 2.

The Union Pacific recently developed a flatcar, Fig. 41, which is equipped with eight revolving racks set on rigid vertical posts designed to support Kaiser-Frazer automobile bodies. The racks, while locked in a horizontal position, are loaded with eight car bodies by overhead cranes, and then turned a full 180 deg for application of eight more bodies. All car bodies are firmly secured to the racks which are then revolved and locked to a vertical position while in transit. In the vertical position, all weight is carried on the car floor and none on the axis of rotation. Further developments simplifying this design, to eliminate the necessity of the rotating feature for loading and unloading, are under way.

Two all-steel depressed-center flatcars, designed to carry a capacity load of 270,000 lb, were delivered to the Canadian National Railways during the year by Canadian Car & Foundry Company, Ltd. Three more were to be delivered late in 1950. Designed especially for the transportation of transformers and other heavy electrical equipment, these 60-ft 4-in. cars, one of which is shown in Fig. 42, have 6-wheel trucks, each of which consists of an integral cast-steel one-piece frame equipped with 30-in. AAR multiple-wear wrought-steel wheels mounted on special large axles with 7-in. × 14-in. journals. The truck springs are AAR coil type, class H-2 in clusters of five. The trucks have a wheel base of 10 ft. The body underframe is cast steel, designed with suitable clearance at ends to permit negotiation of a 133-ft-radius track curve. The length of the depressed section between lugs is 22 ft 7 in.

Co-ordinated studies on the part of the Bangor and Aroostook Railroad, the Great Northern Paper Company, and the Magor Car Company have resulted in a pulpwood car, Fig. 43, designed to handle pulpwood to the water side where a mechanical dumper tips the car and unloads it through two swinging side doors on either side of the car into a chute and thence to the water. These cars are of 50-ton capacity, 46 ft inside length with fish-belly side-sill load-carrying members. The car is divided into two compartments by a full-height transverse center partition. Two swing doors on each side of the car are hinged to the side plate and latched closed at the side sill. Each swinging door carries a built-in 4-ft 6-in. sliding door with bottom rollers.

The GM&O built 100 pulpwood cars using cast-steel underframes and cast-steel end posts, and longitudinally slatted steel floors. The castings were designed and cast by General Steel Castings Company.

The expansion in merchandise service, particularly the bid on the part of the railroads for increased LCL business by providing more regular, dependable, rapid merchandise schedules has further brought into the foreground the need for special equipment to fit this service. Means for blocking the lading in position and provisions for a removable second level or floor in freight cars have been worked out, and previously reported on, by both the Pennsylvania and the Milwaukee Railroads. The NYC recently designed a simple slatted wood bulkhead which can be anchored by means of five sliding anchor bars, two to each side wall and one to the floor of the car, to block lading securely against longitudinal shifting.

In merchandise service, the Pennsylvania is continuing the use of steel merchandise containers, each having a capacity of 12,000 lb loaded on flatcars. The Pennsylvania also has introduced into its merchandise service the use of aluminum-covered plywood containers measuring 4 ft × 4 ft × 4 ft and having a capacity of 1500 lb each. The bottom half of one side drops down and the top half folds back for ease of loading and unloading. The containers are handled on fork trucks or moved on their own casters.

General American Transportation Company introduced the General American-Evans D-F, or "damage-free" car. These cars utilize the Symington-Gould freight truck and the Duryea underframe for improved riding and maximum protection of lading. The Evans damage-free lading device, originally introduced in 1941, is utilized to permit flexible double-decking or shelving of lading and the blocking of this lading to minimize longitudinal shifting.

The Angus Shops of the Canadian Pacific recently completed a 50-ton aluminum boxcar designed by the Aluminum Company of Canada for the Roberval and Saguenay. This car, illustrated in Fig. 44, is said to be the first boxcar with an all-aluminum body, including the underframe. The complete underframe, including center sills, bolsters, cross-bearers, and cross-ties, is of aluminum, but the center sill filler and the rear draft lugs are of welded steel. The weight of this car is 34,400 lb, representing a saving of approximately 11,000 lb compared to a conventional design. Because of this extremely low weight the load-compensating type of brake is used.

The Canadian National has built additional refrigerator cars using overhead ice bunkers. Eight overhead ice tanks, each filled through an individual hatch in the roof, can be filled with pure ice or brine ice where low temperatures are required. Air circulates through an air space between the underside of the tanks and the false plywood ceiling in the car, thence downward through a false wall on each side of the car, below the floor racks, and rises between the lading and then through a longitudinal center opening between the bunkers. For winter protection of lading, charcoal heaters, suspended beneath the underframe, are used. The overhead bunkers and the air ducting are said to give better air circulation and more uniform temperatures, as well as to increase the lading floor area per car. All-metal welded floors are used to eliminate water seepage into the floor structure of the car.

The AAR has submitted an interim report on its refrigeration-car research program. The AAR is investigating vapor barriers in insulation; water ice, dry ice, and mechanical cooling means; and air circulation means within the car. It is anticipated that this program eventually will furnish valuable data for many design improvements in refrigerator cars.

During the year Pullman-Standard completed fifty 95-ton-capacity copper-ore cars for the Santa Fe. These cars, one of which is shown in Fig. 45, are of extremely sturdy and heavy construction, especially designed for severe service. The underframe and floor structure, in particular, are of heavy, built-up, welded steel plate and shapes.

Flooring for freight cars has been given intensive study by manufacturers as well as by the railroads because of the great damage done to wood floors by lift trucks and blocking nails. Several years ago the Great Lakes Steel Company introduced its nailable steel flooring. On some mill-type gondolas, built for the St. Louis-San Francisco by Pullman-Standard, a welded flush steel floor was used to give a smooth surface with no projections such as rivet heads which might damage or interfere with lading. Boxcars with heavier wood floors than the customary $1^3/_4$ in. are being used. Three longitudinal steel floor stringers on each side of the center sill instead of two have been introduced to withstand the heavier floor loads now being imposed.

ACKNOWLEDGMENT

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CONTINUE YOUR EDUCATION—

A Message to Young Engineers

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INTRODUCTION

THE future is exceedingly bright for young engineers. Technically trained men are urgently needed in all functional fields of engineering and management. Present forecasts indicate a shortage of engineers for a number of years to come. To grasp fully the many opportunities, the engineer must have a broad professional outlook as well as technical competence. In short, he must have "professional competence." This paper presents a self-development plan for the young engineer during his first five years of practice.

WORKING ON THE RIGHT JOB

I want to stress the importance of working on the right job—one for which you are well qualified by virtue of your education, aptitudes, and interests. I am not implying there is only one job for which each of you is qualified. There are those who would be eminently successful in any one of many fields of endeavor. However, in the case of most of us, there are certain jobs or job families for which we are better fitted than others. There is ample proof that a person is most productive in a job he does well and in which he is happy. A job will seem hard only if you would rather be doing something else. Then, too, I must emphasize the importance of your continuing to grow professionally. Successful men maintain an upward growth curve, ever raising their ceiling and thus their ability to assume greater responsibility. Unfortunately, a number of seemingly capable men level off rapidly after graduation.

Each of you has a personal interest in the question, "Where will I be five, ten, twenty years from now?" Your future will depend mainly upon the kind of foundation you establish in college and during your first five years in industry. We in management are interested in your development. The future of our companies, in fact, the very existence of our industrial society, depends upon your leadership. The real question is, "What are you doing to prepare yourself for the new responsibilities which will be thrust upon you?"

It is essential that you appreciate the importance of your first five years in industry. Think of the period as one in which you are learning the business, finding your place in an organization, increasing your understanding of fundamentals and their application, and shaping your professional goals. To grow professionally, you must continue your education. All too frequently the young engineer loses his bearings; thus his early years in industry are characterized by shifting from job to job, frustration, and educational and professional inactivity. This tremendous waste of time and talent can be avoided by careful planning on your part and the guidance of your employer.

Admittedly, the transition from college to engineering practice is a critical period. Your task of preparing yourself for a position of responsibility in a dynamic economy is not an easy one. It is much easier, however, if you recognize your problem and face it squarely. A realization of the difficulties you will encounter will aid you in preparing an adequate plan for a professional career. Whether you progress during this period or merely mark time will depend, in a large measure, upon your ability to size up your problem, and upon your attitudes.

You have been taught the engineering method of solving problems. Do you apply this type of thinking to sizing up the industrial situation in planning your career? To understand your need for continuous education and training you must have some conception of the dynamics of modern industry. Perhaps I can make my point clear by giving you a thumbnail sketch of the changing industrial scene.

INDUSTRIAL SCENE CHANGING

The industrial scene confronting the young engineer today is quite different from the comparatively simple scheme of even a quarter-century ago. In this short period of time, the scope of industrial operations has increased tremendously. The growth of modern business brought powerful labor unions and countless government agencies, each exerting its influence upon management's decisions. As a result of technological developments, industry has become increasingly technical and complex. The independent craftsman of yesterday has been replaced by the scientist, the design engineer, the cost accountant, the labor attorney, and other specialists. Moreover, industry is assuming greater social responsibility. As the general level of education rises throughout the nation, management is becoming more responsive to the reactions of the worker, and to the opinions of the silent partner in every business—the consuming public. Despite the technological changes and complicated relationships, business must operate at a profit if it is to continue to exist. The impact of social and technological change will be greater in the next decade.

The young engineer therefore finds himself in a complex industrial setup with a high division of labor, complicated lines of authority, and established behavior patterns. While the craftsman of former years grew up with the business, the present-day engineer steps into a strange organization, at a relatively high level, and he has not had the opportunity to learn the methods and problems of the concern.

The situation described poses many interesting questions. For the purposes of our discussion, I should like to emphasize two points:

1 Technical competence alone is not enough to cope with the problems of modern industry. You must be professionally competent. By professional competence, I mean technical competence plus the ability to deal effectively with the human-relations problems of your job and in your community. To be professionally competent, you must be a good engineer and a good citizen in the broadest sense of the terms.

2 You can no longer bank on merely growing up with the business. You must formulate a program of positive action for your own development.

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A SELF-DEVELOPMENT PLAN

A sound development plan will assure proper direction of your efforts. The study required to formulate such a program will prove invaluable in clarifying your thinking concerning your immediate and long-range objectives. Design your plan to increase your technical and social skills, and to broaden your horizons. Remember, the plan must be tailored to fit your particular needs. Let us discuss some of the major headings of your plan.

Learn Through Experience. Know your company. Learn as much as you can about its products, policies, and people. Know your job and related jobs. Periodically, analyze the personal and technical requirements of your job and the other jobs for which you are preparing yourself. Make sure that your concept of what is important about your job is the same as your boss's. It is equally important to take stock of yourself. Determine if your abilities are being used at the highest possible level. Detect your deficiencies. Learn through your own experience and mistakes, and from the experience and mistakes of others. Be loyal to your organization, and work on the basis that ability and accomplishment eventually will be recognized and rewarded.

Continue Your Education. Although an engineer cannot continue his formal education on a full-time basis forever, he must continue to study during his entire career. The educational stem of your development plan should include informal as well as formal education. Three areas of education should be considered.

"Engineering graduate study" in fundamentals leading to advanced degrees to develop further your technical competence.

"Business education" in economics, accounting, finance, law, marketing, and management to increase your understanding of business fundamentals and their application in industry.

"General education" in the social sciences, and the humanities for your own enjoyment and personal development.

Of particular importance is the development of skills in human relations, and an understanding of their use in getting things done through the efforts of others. Obviously, skills in human relations cannot be learned solely through textbooks, but study and reflection together with experience in dealing with people is essential. All of us would benefit greatly from a better command of the tools of communication in both the spoken and written word; from a deeper understanding of human behavior and motivation; and from a broader appreciation of the historical background of the institutions which have made our industrial society so great—the family, the church, public education, and constitutional government. These matters may seem quite remote in the normal work-day, but, in fact, these are very practical matters. For if we fully appreciated the struggle for individual freedom through the ages, we would not have to be urged to vote.

A personalized educational plan will keep you mentally alert, abreast of new developments, and broaden your background. Moreover, educational pursuits give you confidence and a sense of personal accomplishment. You are urged to start your educational program soon after you take your first job. Experience has demonstrated, unless the young engineer forms an educational plan soon after he leaves college, he is not likely ever to do so. Your program of continued education will serve as a supplement to, rather than a substitute for, a sound undergraduate engineering education.

A sizable number of universities are rendering a real service to professional development through evening courses on both the graduate and undergraduate levels. Many of these programs are designed especially for the mature person employed full time in industry. Although the opportunity to enroll in graduate courses leading to advanced degrees is somewhat limited outside the large industrial areas, the great majority of engineers have ample opportunity to pursue some kind of educational work.

Participate in Professional Activities. Participation in engineering societies and civic organizations does much to develop the well-rounded individual industry needs. Contact with people with different backgrounds and interests broadens your point of view and brings new ideas into your company. One of the best ways to develop a professional viewpoint is to associate with people who have a broad outlook concerning their jobs and community responsibilities. Committee activities promote true teamwork rather than a mere follow-the-leader attitude. The preparation and presentation of papers builds self-confidence and gives the professional employee recognition in his company and community.

PERSONAL QUALITIES

In your quest for knowledge, do not overlook the development of those personal qualities essential to success in every field. Integrity and courage, together with an appreciation of professional ethics, loyalty to your company, and proper regard for confidential information are inherent characteristics of a professional man. Although these qualities are well known to all, each of us must constantly remind himself of their importance. Inasmuch as these qualities are obviously indispensable, let us discuss several attributes whose importance may not be so apparent. The following qualities are especially significant:

Ability to Create Challenges Within One's Self. Successful men have the ability to devise immediate and long-term objectives which impel them toward achievement—call it drive, motivation, or desire to get ahead. The goals you set and your ability to work toward them are important factors in your development. Without worth-while aspirations you cannot expect to progress. However, to achieve a happy and productive life, do not allow your ambitions to outstrip your capabilities. The man who permits his ambitions to get out of hand never can do any job well.

Adaptability. To progress, one must adjust himself to changing conditions. In part, adaptability is a result of a good fundamental education and broad experience. More than this, it is mental flexibility. It is the attitudes by which one will react positively toward assuming responsibility, learning a new skill or specialty, moving to a new position or place, making new friends, and taking a calculated risk.

Effective Expression. Getting good ideas is only half of the battle. Even the best ideas have to be sold. The ability to express one's self through both the written and spoken word is an attribute of major importance. The engineer must use the language convincingly in conversation and in prepared talks, or through letters, articles, and reports.

Response to Adversity. A professional career is not all smooth sailing. Sometimes, the best plans go wrong. How the individual responds to adverse conditions has a bearing on his future. A sound basic philosophy of life acts as a stabilizer when the going gets rough. The young engineer needs to realize there are no short cuts to success in life. Often the way which seems to lead to wealth and fame proves to be a dead-end street.

ENCOURAGEMENT BY MANAGEMENT

Although the purpose of this paper is to emphasize the individual's responsibility for his own development, I am not unmindful of industry's stake in education and training. In-

(*Continued on page 316*)

PROPERTIES *and* PERFORMANCE *of* SILICONE LUBRICANTS

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SILICONE fluids have certain inherent characteristics that make them especially interesting as lubricants in view of the present demand for high productivity in industry and the severe operating conditions to which military equipment is exposed. There is an increasing demand for lubricants with high load-carrying capacity and for lubricants that will withstand very high operating temperatures, as well as the very low temperatures specified for many military applications. These are requirements that give new significance to certain properties such as the thermal stability and the relative indifference to temperature extremes that are characteristic of silicone fluids and of the greases compounded from them. It seems appropriate, therefore, to review the physical characteristics and to summarize the functional tests and the application data now available on the silicone lubricants that have acquired some commercial importance.

PHYSICAL CHARACTERISTICS

Various silicone lubricants are described briefly in Table 1 and classified according to their physical state, their chemical structure, and the kind of thickening agent used.

TABLE 1 CLASSIFICATION OF SILICONE LUBRICANTS

Type	Physical state	Phenyl content	Thickening agent	Viscosity range in centistokes at 77 F	Consistency range ASTM penetration	Useful temperature range, deg F
A	Fluid	None	.....	0.65 to 1000000	.....	—125 to 350
B	Fluid	Low	.....	50 to 60000	.....	—100 to 400
C	Fluid	Medium	.....	100 to 150	.....	— 58 to 500
D	Fluid	High	.....	500	.....	— 8 to 500
E	Grease	None	Silica	.....	220 to 250	— 60 to 400
F	Grease	Low	Lithium soap	.....	200 to 380	—100 to 300
G	Grease	Medium	Lithium soap	.....	200 to 380	— 40 to 400
H	Grease	High	Carbon black	.....	260 to 300	— 20 to 500

All of the type A fluids are pure water-white liquids. Described in the chemical literature (1)[1] as methyl-siloxane polymers, fluids of this type contain no phenyl groups. They form a continuous series with viscosities ranging from 0.65 centistokes for the lowest-molecular-weight fluid to over 1,000,000 centistokes for the higher polymers in this group. The lower members of this group are volatile with freezing points ranging from —123 to —67 F; flash points range from 30 F to more than 525 F.

The higher members of the series, with viscosities greater than 50 centistokes at 77 F, show little change with increasing molecular weight. Pour points range from —67 to —47 F. Flash points are at or above 600 F. Other physical properties of representative fluids in group A are given in Table 2.

These fluids are used in damping devices such as viscous torsional-vibration dampers (2), shock absorbers, and dashpots. They are used as lubricants for porous-bronze bushings, fiber and plastic gears, centrifugal oxygen compressors, and oxygen valves operating at temperatures below 390 F.

Type B fluids are produced in viscosities ranging from 50 to 60,000 centistokes at 77 F. Polysiloxane fluids of this type contain a low ratio of phenyl to methyl groups. They are, therefore, quite similar to the type A fluids in their physical characteristics.

Type B fluids differ from type A fluids, however, in two important respects. (*a*) The higher-viscosity members of this series possess very low freezing points. (*b*) The heat stability of a high-viscosity type B fluid is approximately 20 times that of a type A fluid of comparable viscosity. The physical properties of a type B fluid are given in Table 2.

Type B fluids are used where an extremely wide range of temperatures are involved.

The fluids classified as type C possess a medium phenyl content and are produced in viscosities ranging from 100 to 150 centistokes at 77 F. They are extremely heat-stable materials and possess high flash points. The physical properties of a typical fluid of this type are given in Table 2.

TABLE 2 TYPICAL PHYSICAL PROPERTIES OF SILICONE FLUIDS

Type	Viscosity, centistokes at 77 F	VTC[a]	Pour point, deg F	Flash point, deg F	Volatility at 500 F, per cent	Gel time at 500 F, hr
A	1.0	0.37	—123	110	——Distills——	
A	10	.60	— 67	600	5	24[b]
A	500	.61	— 58	600	5	24[b]
B	500	.64	— 70	550	9	400[b]
C	150	.76	— 58	600	10	750
D	500	.83	— 8	600	15	1000

[a] VTC = viscosity temperature coefficient = $1 - \frac{\text{viscosity at 210 F}}{\text{viscosity at 100 F}}$

[b] Gel times can be increased by addition of a suitable oxidation inhibitor.

Type C fluids are used as lubricants for journal bearings, ball bearings, and porous-bronze bushings where long life, serviceability over a wide temperature span, or heat stability are required. Typical applications include the permanent lubrication of clocks, instruments, parking meters, and electric razors.

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

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The type D fluids are the most heat-stable silicone fluids known. At present, only one fluid of this general type is commercially important. It is a straw-colored oil with a viscosity at 77 F of approximately 500 centistokes. Some of the physical properties of this fluid are given in Table 2.

This fluid, either alone or combined with graphite, is well adapted to high-temperature lubrication. It is used as a lubricant for oven doors and for valves handling corrosive materials at high temperatures. It is used to prevent the seizure of hold-down bolts and guide pins on presses, and of the nozzles on injection-molding machines. It is also used as a lubricant for oven conveyers at temperatures above the limits of type C fluids.

Silicone fluids of all four types have certain properties in common. They all have relatively flat viscosity-temperature slopes. They all possess a high order of thermal stability and oxidation resistance. They all contain methyl or phenyl groups or a combination of both methyl and phenyl groups.

The type A or dimethyl-polysiloxane fluids show the least change in viscosity over a wide temperature span. The viscosity-temperature slope becomes progressively steeper as the phenyl content is increased. This progression is demonstrated in Fig. 1 showing changes in viscosity with increasing temperature. A similar plot is made for an SAE 30 oil. To make the comparison valid, only silicone fluids with a viscosity of 500 centistokes at 77 F are represented.

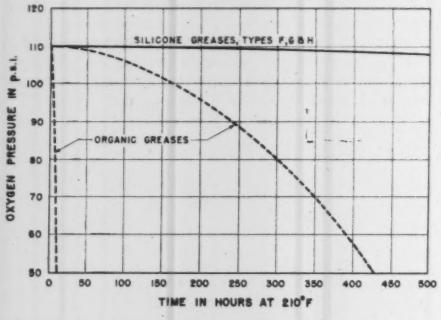

FIG. 1 EFFECT OF TEMPERATURE ON VISCOSITY OF VARIOUS SILICONE FLUIDS AND AN SAE 30 OIL

Contrary to normal expectations, the type D fluid which has a steeper viscosity-temperature slope than type A, B, or C fluids, still shows the greatest heat stability. Among fluids containing both methyl and phenyl groups, both heat stability and viscosity-temperature coefficient increase with increasing phenyl content. This is indicated in Fig. 1 and by the data given in Table 2. The gel times given for types A and B fluids can be increased, however, to at least 750 hr at 500 F by the addition of a suitable oxidation inhibitor. It is generally true, however, that some measure of heat stability must be sacrificed if a minimum change in viscosity over a wide temperature range is required.

From these four fluids, the four silicone greases briefly described in Table 1 are prepared. The properties of these various greases are determined by the type of fluid and by the thickening agent used in compounding them. Since both the F and G type greases are thickened with organic soaps, their life is limited to some extent by the thermal stability of the thickening agent. A special carbon black is used as the thickening agent in preparing the grease classified as type H. This is, therefore, the most heat-stable of the silicone greases. A valve

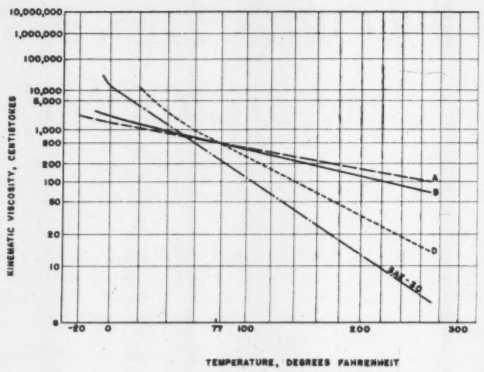

FIG. 2 RELATIVE OXIDATION RESISTANCE OF SILICONE AND ORGANIC GREASES AS INDICATED BY CHANGES IN PRESSURE WITHIN AN OXYGEN BOMB AFTER HEATING FOR 500 HR AT 210 F IN PRESENCE OF BRASS

lubricant, classified as type E grease, is prepared by thickening a silicone fluid with silica.

Some properties of these various greases are given in Table 3. The relative oxidation resistance of silicone greases and various organic greases is indicated by the results of oxygen-bomb tests reported graphically in Fig. 2. Test conditions were 500 hr

TABLE 3 TYPICAL PHYSICAL PROPERTIES OF SILICONE GREASES

Type	ASTM penetration	Apparent density, 77 F/77 F	Dropping point, deg F	Bleed,[a] per cent	Evaporation,[a] per cent
E	240	0.98	None[b]	1.0	1.5
F	320	0.92	400	3.0	3.0
G	250	0.97	400	1.5	1.5
G	310	0.97	400	2.0	1.5
H	300	0.98	None[b]	4.0	1.0

[a] Bleed and evaporation determined after 24 hr at 300 F in a wire-mesh cone.

[b] These materials do not fuse because they contain inorganic fillers.

of exposure, in the presence of brass as a catalyst, to oxygen under a pressure of 110 psi at 210 F.

The type E greases are used primarily as valve lubricants, where steam, corrosive materials, or heat cause rapid failure of organic valve lubricants.

The type F greases are specifically designed for low-temperature applications. They are used to lubricate small motors, instruments, gages, recorders, and similar devices where low or relatively constant torque is required over a wide temperature span.

Type G greases are designed to give long service in ball bearings operating at temperatures from —40 to 400 F. These greases are used as permanent lubricants in the ball bearings of electric motors and as heat-stable lubricants for ball bearings exposed to high temperatures in equipment used in processing ceramics, glass, and textiles.

Type H grease is designed for service at temperatures from —20 to 500 F and higher. It is also resistant to attack by water. This type of grease is used to lubricate oven conveyers and kiln carts, high-temperature regulator valves, stoker bearings, furnace doors, driers, and similar low-speed equipment exposed to extremely high temperatures or to water.

Since most lubricants are used under conditions of shear, a

brief discussion of the rheological properties of these materials is pertinent. A report (3) has been made of the effect of shear on some of the greases and upon the type A fluids.

The type A fluids having a viscosity at 77 F of less than 1000 centistokes, exhibit Newtonian flow at shear rates up to 10,000 sec^{-1}. As the viscosity of the fluids is increased, pseudoplastic flow is encountered. That is, when rate of shear is plotted against shearing stress, deviation from linearity becomes more pronounced as the viscosity of the type A fluids is increased.

This pseudoplasticity is transitory. Upon cessation of shear, these fluids assume their original viscosity. Practical confirmation of these test results is found in the successful use of a type A fluid in viscous torsional-vibration dampers.

The behavior of the silicone greases under shear is similar to that of most organic greases. At low rates of shear, the amount and type of soap is most important. At high rates of shear, consistency is determined largely by the oil. Surprisingly enough, the rheological properties of type H grease compounded with carbon black are similar to those of the type F and G greases, which are thickened with an organic soap.

The stability of the silicone greases classified as types F and G under prolonged shearing in a motorized grease worker is indicated by the values given in Table 4. The ASTM penetration of the type F grease was increased by less than 30 points, and the penetration of the type G grease was increased by less than 25 points after 100,000 strokes.

TABLE 4 EFFECT OF REPEATED SHEARING ON CONSISTENCY OF SILICONE GREASES

Number of strokes	ASTM penetration	
	Grease F	Grease G
60	294	314
1000	307	324
10000	316	340
100000	323	336

FUNCTIONAL TESTS

A variety of functional tests indicate that these silicone fluids and greases have good lubricating properties in antifriction bearings. Where sliding friction between ferrous surfaces is involved, silicone fluids and greases are not satisfactory lubricants under heavy loads or where boundary lubrication is required. In some cases involving sliding friction under light loads, silicone lubricants have been used successfully in steel against steel bearing surfaces.

Journal Bearings. Many functional or simulated functional tests have been conducted to determine the relative effectiveness of silicone lubricants between various metal combinations in journal bearings. The Falex lubricant machine has been used for this purpose, (4). The results of these tests reported in Table 5 indicated that such bearing pairs as steel against zinc, bronze, nylon, chrome, or cadmium will be effectively lubricated by silicone fluids. Babbitt and silver have also been found to be satisfactory bearing materials with silicones.

Zisman and his associates (5, 6) found that a silicone lubricant performed well on a chrome-plated shaft rotating in a bronze bearing. Even at temperatures as high as 425 F, performance was good. They found that the type A fluids were better lubricants for the bearing pairs studied than silicone fluids of type D. In addition to journal-bearings studies, some exploratory work was reported (7) with Pesco-type gear pumps in hydraulic systems.

In general, where heavy loads were involved, independent researchers (7, 8) found that the deposition of a polymerized silicone film was beneficial. This oxidized silicone film was deposited by heating the bearing in the presence of a type A fluid. A combination of silicone fluid and its decomposition film produced desirable effects on both friction and load capacity at sliding velocities as high as 7600 fpm and with an initial Hertz surface stress as high as 126,000 psi (8).

Antifriction Bearings. It appears that the load-carrying capacity of the silicone lubricants in antifriction bearings of standard design is adequate for most applications. Where

TABLE 5 EFFECT OF VARIOUS BEARING SURFACES AND LOADS ON WEAR-PREVENTATIVE PROPERTIES OF SILICONE FLUIDS

(Falex lubricant machine)

Bearing surfaces		Load,	Fluid A		Fluid D	
			Wear in. per min		Wear in. per min	
Vee block	Shaft	psi	× 10^5	Rating	× 10^5	Rating
Steel	Zinc-plated	800	0.7	Good	0	Good
Steel	Zinc-plated	1600	0.8	Good	0	Good
Steel	Zinc-plated	2400	0.8	Good	0.6	Good
Steel	Zinc-plated	3200	1.1	Good	1.0	Good
Steel	Zinc-plated	4000	0.8	Good	0	Good
Steel	Cadmium-plated	800	0.7	Good	0.2	Good
Steel	Cadmium-plated	1600	1.3	Good	0	Good
Steel	Cadmium-plated	2400	15.7	Poor[a]	0.8	Good
Steel	Cadmium-plated	3200	....	..	8.5	Poor[a]
Steel	Chrome-plated	800	4.1	Good	4	Good
Steel	Chrome-plated	1600	0.7	Good	0	Good
Steel	Chrome-plated	2400	0.8	Good	0	Good
Steel	Chrome-plated	3200	0.8	Good	0	Good
Steel	Chrome-plated	4000	1.1	Good	0.2	Good
Steel	Bronze	800	5.4	Good	0.9	Fair
Steel	Bronze	1600	0.8	Good	1.5	Fair
Steel	Bronze	2400	0.4	Good	2.0	Fair
Steel	Bronze	3200	0.4	Good	3.5	Fair
Steel	Bronze	4000	0.8	Good	5.9	Poor
Graphitar	Steel	800	5.7	Poor	6.5	Poor
Graphitar	Steel	1600	....	..	9.8	Poor
Nylon[b]	Steel	800	3.0	Good	....	....
Nylon[b]	Steel	1600	4.1	Good	....	....
Nylon[b]	Steel	2400	4.4	Good	....	....
Nylon[b]	Steel	3200	6.5	Good	....	....
Nylon[b]	Steel	4000	8.9	Good	....	....

[a] Excessive wear caused by removal of cadmium plating.
[b] It is probable that most of the wear reported here was due to deformation of the vee block

the applied load is greater than $^1/_3$ of the rated load, silicone lubricants, in general, and type G in particular, may not give as satisfactory service as petroleum greases. Antifriction bearings are most commonly operated, however, under loads considerably below $^1/_3$ of the rated load where silicone greases give superior performance because of their high resistance to oxidation and to thermal degradation.

Since thermal endurance was one of the primary reasons for evaluating silicones as lubricants, most of the tests reported to date were designed to determine the life expectancy of silicone greases at high temperatures. Most of this work has been done at temperatures close to or above the top temperature limits for organic lubricants. Some typical test data are given in Table 6. Average life values are reported in this table because they are probably more indicative than the wide range of specific values obtained in various test runs. The silicone greases showed a somewhat wider dispersion in test results than the organic greases, but it is likely that development work now in progress will narrow the dispersion and result in an appreciably higher average life for the silicone lubricants.

In Table 6, item 1, an average life of 15,000 hr at a temperature of 255 F is reported for a type G silicone grease in the bearings of an electric motor. This motor was a totally enclosed, fan-cooled Class H unit operated without the fan. A belt-driven generator was used to overload the motor by about 30 per cent to bring the bearing temperatures up to 255 F. After 15,000 hr of operation, the bearings were still in good condition. They were relubricated with silicone grease, type G, and operated for several thousand more hours before the test was discontinued. This is the only test reported in Table 6 that was not carried on until the bearings became inoperable.

Some indication of the relative life of silicone grease, type G, and a high-quality organic grease under identical operating conditions at bearing temperatures of 300 F is given in item 2, Table 6. The silicone grease, with an average life of 5730 hr or 7.8 months compared with 550 hr or 3.3 weeks for the organic grease, increased the life of the bearings by a factor of 10. Bearings heat-treated for operation at 170 C were used to minimize the effects of prolonged high temperature on the bearing metals.

The need for specially heat-treated bearings is demonstrated by the data given in item 3. In these tests, silicone grease, type G, had a very satisfactory life of 6800 hr or 9.4 months at 300 F in bearings heat-treated for operation at 170 C (344 F). Under identical conditions in standard bearings, the same grease had an average life of only 1900 hr or 2.6 months. These and a number of other tests of a similar nature indicate that the bearing metals, heat-treatment, and fit-ups are major factors in determining the life of any grease in bearings operating at temperatures in the range of 210 F to 250 F and upward.

Another direct comparison of the life of bearings lubricated with silicone and organic greases is given in item 4 of Table 5. In these tests the bearings were operated at speeds about twice as great as those used in the tests just described. The average life of bearings lubricated with silicone grease, type G, was about twice the life of bearings lubricated with the "low-temperature" silicone grease, type F, which, in turn, had about twice the life of bearings lubricated with a high-quality, "high-temperature" organic grease. These tests illustrated the fact that silicone greases designed primarily for high- or low-temperature applications are serviceable over a very wide temperature span.

Items 5, 6, and 7 in Table 6 give further evidence of the thermal stability of silicone greases.

TABLE 6 RELATIVE LIFE OF VARIOUS SILICONE AND ORGANIC GREASES IN BALL BEARINGS OPERATING AT HIGH TEMPERATURES

				Operating conditions					
		Bearing			Temperature,	Speed			Average life,[b]
Item	Type of grease	Size	Heat-treatment	Test device	deg F	Rpm	Speed factor[a]	Load	hr
1	G	308	Standard	Electric motor	255	1800	72000	Belt drive	15045+
2	G	310	170 C	Electric motor	300	1800	90000	Belt drive	5733
	W[c]	310	170 C	Electric motor	300	1800	90000	Belt drive	553
3	G	212	Standard	Fixture	300	1800	108000	150 lb	1907
	G	212	170 C	Fixture	300	1800	108000	150 lb	6881
4	G	204	Standard	Fixture	300	10000	200000	5 lb	3103
	F	204	Standard	Fixture	300	10000	200000	5 lb	1741
	X[c]	204	Standard	Fixture	300	10000	200000	5 lb	973
5	G	204	Standard	Fixture	325	10000	200000	5 lb	2133
	X[c]	204	Standard	Fixture	325	10000	200000	5 lb	493
6	G	212	Standard	Fixture	345	1800	108000	0	1850
	Z[c]	212	Standard	Fixture	345	1800	108000	0	50
7	G	204	Standard	Fixture	390	10000	200000	0	206+

[a] Speed factor = (bore in mm) × (rpm).
[b] To failure of the bearing.
[c] Best organic grease tested at this temperature in this device.

It is generally agreed that there is an optimum amount of organic grease for bearings of any given design. The application of less than the optimum amount of grease will reduce the life of the bearing or increase the relubrication schedules. The application of more than the optimum amount of grease will reduce the life of the bearing by causing internal friction and a high temperature rise. Tests have been conducted to determine whether that same optimum amount is applicable to silicone greases or whether a smaller amount could be used because of the high resistance to oxidation characteristic of silicone lubricants. The results of these tests are summarized in Table 7.

Run No. 1 was made in standard No. 212 bearings because conclusive results were expected after a reasonable number of hours of operation at 150 F. Beginning with 25 grams, the amount of silicone grease, type G, was progressively reduced by one half in each of five other bearings. All six bearings were run under a load of 150 lb at 1800 rpm for 1000 hr at 150 F with no apparent difference in performance.

The test was then accelerated by running the bearings at temperatures in the range of 260 F to 300 F. If allowance is made for temperature variations, data given in Table 7 indicate that

TABLE 7 EFFECT OF QUANTITY OF GREASE ON LIFE OF SILICONE GREASE, TYPE G

(In No. 212 ball bearings under 150 lb load at 1800 rpm)

Amount of grease, grams	Operating temperature, deg F	Time to failure, hr
Run No. 1 in Standard Bearings[a]		
0.8	280	1019
1.6	290	1016
3.1	300	484
6.3	300	362
12.5	280	2000
25.0	260	2000
Run No. 2 in Bearings Stabilized at 170 C		
2	280	1550[b]
25	290	2000[b]

[a] Bearings were run for 1000 hr at 150 F before they were brought up to operating temperatures.

[b] Average for 3 runs at temperatures ranging from 260 to 300 F.

quantities of grease in the range of 12.5 to 25 grams give the best bearing life.

Because of the possibility that the results of this first run were invalidated to some extent by operating the bearings at temperatures above those for which the bearings were designed, a second run was made in bearings stabilized for operation at 170 C. In this run, three bearings were packed with 2 grams and 3 bearings were packed with 25 grams of silicone grease, type G. All of the bearings containing 25 grams of grease were in good operating condition after 2033 hr at temperatures ranging from 280 to 300 F. All of the bearings containing 2 grams of grease failed in less than 1750 hr at temperatures ranging from 60 to 300 F. These tests indicate that bearing life can be increased substantially by using as much silicone grease as possible without causing abnormal temperature rise.

High-Speed Bearings. During the first few hours of operation in bearings with a speed factor[2] of more than 150,000, silicone greases produce relatively high operating temperatures. After the first few hours, however, operating temperatures drop down within the range obtainable with organic greases. This same transient phenomenon is observable in many organic greases. Where this initial and transient rise in operating temperatures can be tolerated, silicone greases are serviceable in bearings at speed factors well above 150,000 with a top limit that has not definitely been determined. It is good conservative practice, however, to consider a speed factor of 150,000 as a practical limit on the usefulness of silicone greases of type F and G in high-speed bearings.

In the case of silicone grease, type H, a speed factor of less than 75,000 is taken as a practical limit for this type of lubricant in antifriction bearings even though it has given satisfactory performance in some test runs at much higher speeds.

APPLICATIONS

Laboratory data are essential to the proper evaluation of any new type of lubricant. The most convincing evidence of the usefulness of a lubricant, however, is its performance under actual service conditions. The silicone greases covered in this paper have been used commercially for several years, and a considerable amount of information on their performance under various service conditions has been assembled.

Silicone grease, type E, was developed as a lubricant for plug valves and flowmeters handling corrosive chemicals at high or low temperatures. Under service conditions too severe for organic valve lubricants, it reduces maintenance costs and the hazard of frozen or inoperable valves and pumps. It has been used effectively in valves handling such materials as acetic acid, acetone, methyl alcohol, isopropyl alcohol, formaldehyde, 93 per cent sulphuric acid, furfural, phosphoric acid, carbon disulphide, hot water, and steam.

Evidence of the exceptional stability of silicone grease, type E, is given by its performance in a bank of stellite-treated valves handling hydrocarbon gases at temperatures ranging from 390 to 930 F for about 21 hr each day with temperatures in the range of 930 to 1292 F during the other 3 hr. Three years of experience with silicone grease, type E, has proved that these valves no longer have to be reground; valve life has been tripled; and the cleaning schedule has been changed from once every 4 to 6 weeks to once every 6 to 8 months.

Silicone grease, type H, has proved to be most useful in bearings operating at low speeds and exposed to high temperatures, excessive moisture, and corrosive atmospheres. Open bearings are relubricated with type H grease; sealed bearings are relubricated with silicone fluid, type D.

In one application, silicone grease, type H, was used to eliminate the seizure of bearings and the breakage of connecting links in an oven conveyer system operating at 450 F. A simple schedule of repacking the bearings with type H grease once every 3 months and relubricating them once a month with a few drops of silicone fluid, type D, has replaced a program of almost constant maintenance and experimentation with various methods and types of lubrication.

In another oven conveyer system operating at 375 F, bearing failure was common even with weekly relubrication, and production was further hampered by spoilage due to oil dripping from the trolley bearings. Use of silicone grease, type H, has eliminated the problem of oil dripping from the bearings, and there have been no bearing failures on a relubrication schedule of once every 6 months.

The use of silicone grease, type H, in the trolley bearings and in the 6-in. roller bearings of a core-oven conveyer system, exposed to a hottest spot temperature of 700 F, reduced the amount of power required to drive the conveyer by more than 80 per cent. The roller bearings are relubricated every other week, and the trolley bearings are relubricated every week.

Silicone grease, type F, was designed primarily for low-temperature applications, but laboratory testing and field experience have established the fact that it will also give longer service at high temperatures than most of the high-temperature organic greases. Many applications have been established for this silicone grease as a lubricant for instruments where a relatively constant consistency over a wide temperature range and high resistance to aging are required. In photographic and optical equipment, silicone grease, type F, is used as a lubricant for lens mounts, take-up reels, focusing mechanisms, and transit bearings. The precision and the life of geophysical instruments, electric demand meters, and time clocks have been increased through the use of this type of silicone grease. It is also used in radar tuning devices, microphone switches, and in the gears of x-ray machines. In general, silicone grease, type F, is used where uniform performance is required over a very wide temperature span.

Silicone grease, type H, has a definite speed limitation. In the type F silicone greases, life at high temperatures was reduced somewhat to get better low-temperature performance. Type G silicone greases are general-purpose lubricants that combine much of the heat stability of type H grease with the high-speed performance of the type F silicone greases.

The type G silicone greases are used as "permanent" lubricants in sealed bearings operating at temperatures up to 200 F. They are also used to reduce maintenance costs and lost production due to the failure of bearings operating under conditions too severe for most organic materials.

Silicone grease, type G, is used, for example, as a permanent

[2] Speed factor—(bore, mm) × (rpm).

lubricant at about 200 F in the bearings of blower motors operating in high ambient temperatures. Several thousand of these bearings have been put into service during the past 3 years. None of these bearings has been relubricated, and no bearing failures have been reported which are directly traceable to failure of the grease. Silicone grease, type G, is also used as a permanent lubricant in the cartridge-type ball bearings supplied to a major motor manufacturer for installation in a line of totally enclosed electric motors. Here again, no true grease failures have been reported in a period of more than 3 years. Less spectacular but just as significant is the fact that many electric-motor rewind shops are lubricating the bearings of rebuilt motors with this type of silicone grease and then plugging the grease fitting holes. This assures longer life by eliminating the hazards of dirt and overlubrication in bearings packed with a grease that is resistant to high temperatures and oxidation.

The use of silicone grease, type G, to reduce maintenance costs is demonstrated in several textile-mill applications. In the bearings of 200 to 300-rpm motors driving driers that operate at 350 F, this type of silicone grease remains serviceable for several months under conditions that necessitated daily relubrication with a good organic grease. It has 45 times the life of organic lubricants in the 400-rpm journals through which saturated steam is passed into textile-mill drying cans. It has also been used to advantage on tenter and slasher frames where sliding friction is involved.

CONCLUSIONS

The following conclusions may be drawn concerning the usefulness of the silicone lubricants now available.

1 Silicone lubricants show exceptional resistance to heat and to many corrosive materials.

2 They show relatively little change in physical characteristics over a wide temperature span.

3 Load-carrying capacity may be limited or excellent depending upon the bearing-metal combinations.

4 Silicone lubricants have a long service life in antifriction bearings operating at relatively high speeds under normally encountered loads at temperatures from —100 to +375 F. If the bearings are relubricated, the operating temperature may be increased to as much as 700 F.

5 Silicone lubricants are most useful where organic oils and greases stiffen at low temperature; break down in corrosive atmospheres; bleed, evaporate, or form gums at high temperature.

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Continue Your Education—A Message to Young Engineers

(*Continued from page 310*)

dustrial leaders are devoting special attention to the development of their professional and technical personnel. They know that the individual members of the industrial team must grow if the company is to prosper. Through their well-organized educational and training programs, they encourage individual initiative and self-development. True, many companies do not have well-defined development programs; nevertheless, striking progress is being made. An increasing number of companies are inaugurating training programs. Moreover, colleges and employers are co-operating in offering graduate-study programs in fifteen industrial areas, according to a recent survey.

The engineering societies are keenly interested in your education and professional growth. The American Society of Mechanical Engineers is particularly active, as demonstrated by meetings sponsored by the Junior Committee. One of the most significant developments in recent years is the plan entitled, "The First Five Years of Professional Development," which was prepared by the Engineers' Council for Professional Development Committee on Professional Training. This constructive program should bring about the co-operative action of the colleges, the technical societies, and the employers in the implementation of effective development programs for areas in which adequate opportunities are not available. The ECPD plan recognizes two cardinal principles, namely, that the final responsibility for professional advancement rests squarely on the individual's shoulders; that the engineering profession must provide the young engineer the opportunity for development and a favorable climate in which to grow. I assure you, your problem of developing professional competence has the attention of the leaders of the engineering profession.

Chances for Promising Young Men

WHAT, then, can we do to secured the desired leadership beyond hunting for it? At least one thing we can do in a manner which proved extraordinarily fruitful during the emergency of World War II. This is to give promising young men the chance to develop and demonstrate the desired qualities.

I have often though of one aspect which has been a natural, and, on the whole, an unfortunate trend after a war. The war closes with a peak number of experts of various types who have demonstrated unusual value to the war effort. In this respect we emerge from the war strong. But the tendency is to continue to depend on these men overlong for leadership in their fields of interest to national security. After a few years they have become too old, or too out of touch with the younger men who are coming along as the active contributors in their fields. To help overcome this tendency toward obsolescent leadership in the field of military technological developments, for example, the Research and Development Board under Dr. Bush's leadership established the policy of limited terms of service on its various technical committees. The membership of these committees started out almost completely composed of men who had been prominent in their respective fields during the war, but the plan called for a gradual replacement with new and usually younger talent, so that new generations would gradually become acquainted with the problems and be tested as to performance.

Such a plan is certainly basically sound.—Karl T. Compton, *Electrical Engineering*, March, 1951, p. 194.

The ECONOMICS *of* ATOMIC POWER[1]

By F. E. BALDERSTON

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WHEN a radically new machine or technical process is first put to experimental use, men who are aware of it can rarely judge the significance of what they see. Perhaps our new control over the release of energy in the process of nuclear fission heralds a great burst of technical development, and an era of sweeping social and economic change comparable with that proceeding from the impact of Mr. James Watt's crude little steam engine. Perhaps, on the contrary, atomic energy will be important in the research laboratory and in the Air Force briefing room but not in day-to-day economic life.

A new study,[2] directed by Messrs. Schurr and Marschak, gives judicious and scholarly attention to the atom as a power source, mainly through the use of nuclear reactors hooked to conventional electric generators. In part one, the authors compare the effectiveness and costs of nuclear power with other sources of electricity, and they estimate the probabilities for use of substantial amounts of such power in the United States and other countries. In part two, a series of industry analyses trace the potential direct effects of atomic power upon nine industries in which energy—as heat or as electricity—is an important element of cost. Broader questions of economic development are considered in part three: potential effects upon real income, and upon the geographical and technical composition of industry in modern industrial economies like that of the United States; and similar effects in so-called "backward areas" not now heavily industrialized.

It is evident that the authors have circumscribed their survey with a number of limiting assumptions. They have ruled out of consideration any study of the economic effects of atomic energy as an explosive—whether military or "civilian." Radioactive materials may eventually prove usable on a large scale in industrial chemical processes and methods may be discovered for direct emission of electricity from nuclear reactors, without the use of conventional generators. Both of these potential applications of atomic energy are still highly problematical, however, and the authors specifically omitted them from their survey because the technical difficulties are nowhere near solution. The authors also direct their investigation toward the economic *feasibility* of peacetime uses of atomic energy, making it clear that they cannot forecast the degree to which military uses of fission processes may retard or prevent peacetime applications of these processes.

Sober as they are, the authors are dealing with such a spectacular subject that they cannot help making some startling statements. The *fuel* costs of atomic power are, for example, expected to be negligible—in the range, 0.002 to 0.020 mill per kilowatt-hour. This is based on the presumption that nuclear reactors producing power will use up only natural uranium, enough fissionable substances being released from the chain reaction to sustain intact the initial investment of (very expensive) U-235, U-233, or plutonium. Furthermore, one pound of natural uranium (at $20 to $50 per pound) is expected to be the energy equivalent of 1250 tons of coal. Fixed plant will, however, be both substantial and costly, and total costs per kwh are estimated to fall within the range 4.0 to 10.2 mills per kwh for a 75,000 kw plant that is operating at 50 per cent capacity. The intermediate section of this range is approximately equal to costs per kwh of operating a modern thermal plant, burning coal at $8 per ton and operating at 50 per cent of capacity; but at fuel prices in normal years, only the lowest nuclear cost could begin to compete with coal. Since the variable costs of generating electricity from a nuclear reactor are negligible, operation at full capacity would cut the unit cost figures almost in half.

For the United States, these figures imply that atomic power may presently be quite feasible as an alternative to conventional thermal generation, especially in areas far removed from cheap sources of natural fuels. In such cases, the fact that a nuclear power plant can operate almost without reference to transport costs may tip the balance in its favor. Nuclear power also develops a cost advantage, of course, when coal or other natural fuels rise in price. In 1946, a year of severe world-wide coal shortage, generation costs in the modern thermal plant were estimated to be 10 to 20 per cent higher than at the 1937 average price of coal. It is noteworthy that even in its lowest conceivable cost ranges, nuclear power cannot be expected to compete with large-scale hydroelectric generation in the best sites, where costs of one or two mills per kwh are not uncommon.

While the authors are skeptical of a great short-term impact on the American power industry, they point out potentially sweeping alterations in costs of power supply in many other countries which are deficient in low-cost natural fuels, or in which the estimated water-power resources are either fully in use or too remote from centers of population to be usable. Taking the problem of foreign exchange into account, the authors estimate that a country like Argentina, which must import coal for most of its power supply, would save foreign exchange annually at the rate of nearly five dollars per kilowatt capacity; this example is constructed to include the foreign-exchange cost of importing a substantial fraction of the reactor's equipment. If atomic power becomes available to such countries, the authors predict both direct increases of productivity and real income through greater energy use, and even greater induced shifts of the location and composition of production.

The industry analyses of part two are intended to show the possibilities for cost reduction, changes in process, and changes in locational patterns as atomic power becomes available. Of the nine industries covered, only one—residential heating—necessarily involves the direct use of the nuclear reactor as a heat source; the rest consider the impact of electricity generated by the use of nuclear reactors. The most favorable prospects are predicted for the use of atomic power in phosphate fertilizers, and iron and steel. Each of these industry studies must encompass a considerable range of variables: the probable trends in the price and quantities used of the produce, and the increase in the quantity demanded if cost reductions result in lowered prices; the technical processes themselves; and the location factors stemming from the geographical concentration of raw materials and of the market for the final product. As one would surmise from the data given regarding direct power costs,

[1] One of a series of reviews of current economic literature affecting engineering, prepared by members of the Department of Economics and Social Science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

[2] "Economic Aspects of Atomic Power," by S. H. Schurr and J. Marschak, Princeton University Press, Princeton, N. J., 1950, 289 pp., $6.

changes of the locus of production are often more likely than spectacular cost reductions.

In the case of aluminum, whose production requires 18,000 kwh per ton, the bedrock minimum among nuclear power estimates (at a 100 per cent plant factor) is not low enough to displace present low-cost hydroelectric installations in providing electricity for the reduction of alumina to pig aluminum at present locations. However, aluminum has been leading the extraordinary growth of the light-metals industry, and the prospects are that the rate of growth of aluminum output will be maintained for some time to come. If this assumption holds, about 3.5 million kw of power capacity will have to be provided between now and 1960 or 1970 for the processing of these increments to U. S. output of the metal. It is at least plausible that not enough cheap sites for hydroelectric generation will be available, or that construction costs will have risen sufficiently, to place new hydroelectric capacity roughly on a par, costwise, with the probable costs of atomic power. Cost tendencies such as these, when combined with the cost advantage accruing to atomic power through placement of refining installations at points of minimum transport cost, make atomic-powered aluminum production a very likely prospect. Such production would be concentrated either at the bauxite deposits, or at ports of entry for imported alumina, close to the larger domestic markets for aluminum metal. Other countries having less hydroelectric capacity than the United States would be likely to benefit more markedly by cost reductions in their production of aluminum.

Three other industries that are covered in the survey—chlorine and caustic soda, phosphate fertilizer, and iron and steel—involve the actual or potential application of atomic power in electrolytic processes. The first of these is a market-oriented industry in which electricity is a considerably smaller percentage of unit cost than in the case of aluminum; furthermore, in contrast to aluminum, the combined weights of the products (chlorine and caustic soda) are about equal to the weight of salt, the raw material that is electrolyzed. While the authors predict that some use of atomic power will be feasible in this industry, they anticipate no substantial cost reductions or changes of the location of production.

More favorable prospects are accorded to atomic power in the production of double and triple superphosphates. Most of our present-day phosphate output is produced by a chemical process and is market-oriented. Electric smelting of phosphorus from nearby phosphate deposits has been done on a commercial basis for some years by the Tennessee Valley Authority, but TVA power is not available near the major phosphate-rock deposits in Florida. The authors conclude that atomic power may stimulate the use of electric methods of reducing phosphate rock but will not result in very substantial cost reductions as compared with the chemical method of producing double superphosphate.

Iron and steel production has typically developed in integrated plants which combine ore smelting in the blast furnace, open-hearth conversion of pig iron to steel, and rolling operations. Quite drastic locational shifts and considerable changes in the scale of iron and steel production are anticipated if (*a*) the reduction of ore to sponge-iron by the use of electrolytically-produced hydrogen proves commercially feasible; and (*b*) the present minor use of electric furnaces to replace the open hearth is extended.

Other industry studies examine the use of nuclear reactors as a heat source in the production of cement and bricks and the supply of district heating in residential areas, and the effects of atomic electric power in flat glass and in railroad transportation.

The final section of the book carries to a tentative conclusion the study of induced effects of atomic power upon real income and the rate of economic development in intranational regions and national economies. The direct increment to real income in the United States in the relative short run is roughly estimated at 1 per cent. Greater impact might result from the development of wholly new processes based upon cheap power.

In examining the prospects for using atomic power to speed the rate of economic development in essentially nonindustrial countries, the authors rely rather heavily upon the "model" which has been evolved by Colin Clark and the League of Nations economists: industrialization by easily discernible stages, proceeding from the strictly localized agrarian economy to cash-crop agriculture, to "simple" industrial production, and finally to the development of heavy industry. This is supplemented by some discussion of the cumulative nature of the industrialization process, under favorable circumstances, and of the limitations upon industrial development in many countries where capital is scarce, skill levels are low in relation to the knowledge required for industrial work, and the resource base is usually small relative to the pressure of population. In this context, atomic power may provide some impetus to development, since it can be supplied free of transport cost and therefore at some capital saving as compared with thermal energy, which requires greater direct investment per kw of capacity.

This attempt to gage the effects of atomic power on industrialization is perhaps the most important of all the estimates made in the survey. It appears to be less decisive in tone and in results than the other projections, principally because any question of cumulative economic development involves a very large number of social, economic, and technical variables, which, while crucial to the discussion of industrialization, are almost wholly qualitative and have not yet been fitted into a satisfactory theory of economic development. What may be required for cumulative industrialization, especially under adverse conditions, is the conjunction of new technical possibilities with a pent-up desire for quite rapid adjustments of social structure and economic organization. Otherwise, in a country like India, increases of productivity and real income will be dissipated wholly in increases of population; per capita income will not rise, capital accumulation will not accelerate, and the process of development will not become cumulative.

The authors of this study could not be expected to provide us with a whole new theory of industrialization. They are to be congratulated for rendering a comprehensive account of the prospects for atomic power to date.

WE cannot expect to be both comfortable and happy in the immediate future. We shall have to strip ourselves of excess fat and gird ourselves for a long fight whether it be a hot war or the present war of attrition. Engineers have always constituted a stable and constructive element in our society. Theirs is a profession founded on the concept of ministration to the people. Theirs is a discipline devoted above all to practical rigorous thinking and planning. Who, better than they, could take the initiative in suggesting that it is better to sacrifice a few of the external niceties of our own way of life now in order that we may be sure of passing it on intact to those who come after us?

Who, better than they, to get in and work, to solve some of the dozens of problems we face nationally in this period of transition in our national life? There are opportunities all about for those with the professional and administrative skill and the willingness to undertake sometimes disagreeable jobs. On the way in which we meet the present emergency, on the wisdom which is brought to bear, on the devotion of our citizens everywhere, will depend the way in which we and our children live our lives for a generation to come.—Vannevar Bush, *Electrical Engineering*, March, 1951, p. 201.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

Compiled and Edited by J. J. Jaklitsch, Jr.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

Safety Programs

ORGANIZED company safety programs merit a key place in the management plan because, judiciously handled, they can be profitable tools, it was stated by Daniel Farrell, assistant area superintendent, Shell Pipe Line Corporation, Houston, Texas, at a Safety Committee technical session during the 1950 ASME Annual Meeting. Business conditions or factors such as effectiveness of supervision, employee and public relations, customer acceptance, productivity, service continuity, reduction of waste, and reduction of absenteeism, can be improved through a well-planned and carefully administered safety program.

To illustrate how safety promotion can create effective two-way channels of communication between workers and management, Mr. Farrell described experiences in the Shell Pipe Line Corporation, a company with 1500 employees operating 6300 miles of pipe lines in the southeastern states.

Some of the channels cited by Mr. Farrell to achieve individual job safety through communications are as follows: Safety chapter meetings, poster services, monthly accident reports, house-organ articles and editorials, fire-fighting demonstrations, first-aid training, supervisory training, employee training, instruction by foreman, on-the-job safety meetings, letters from general management, suggestions by area safety engineers, and instructions by area and division superintendents.

The best channels of two-way communications, he said, are provided by safety chapters. Twenty-nine of these have been organized along the pipe line to include all rank-and-file workers and their direct supervisors. Meetings are held at night on employees' time and more than 80 per cent of the workers attend them regularly. Division, area, and head office supervisors are always invited.

The meetings usually feature two or three items such as a short talk by a local citizen, a description or discussion of a company policy, the showing of a selected motion picture, or the presentation of service and safety awards, plus a brief talk on safety. The last is followed by a general and frank discussion of any unsafe local conditions.

Supervisors join in the safety discussions, and the superintendents are expected by the management to soon correct any unsafe conditions. Often in the past, and of late when they developed, other irritating working conditions have been brought out and discussed freely at the meetings. Corrective action has quickly followed.

Effective channels for work improvement are on-the-job safety meetings, Mr. Farrell said. These are held by each foreman with his crew of workers the first few minutes on the job each Monday morning. He has at hand a mimeographed safety message prepared by the superintendent or the safety engineer that can be read aloud to the crew in two or three minutes. Each message aims to provoke several minutes of discussion by the crew members in its application to their current work problems.

The value of on-the-job safety meetings for the promotion of service continuity, productivity, and waste reduction lies in the fitness of the place and time for selling these directly applicable ideas. These on-the-job meetings were started during the wartime tempo when accidents were increasing. They brought an immediate reduction. Productivity in our business means more barrel-miles of oil transportation, Mr. Farrell said, and our employees have been able to boast of our new record line throughputs by attaining better and better service continuity. This latter is the pay-off for utility companies, common carriers, and other firms producing service instead of goods.

Equipment inspection tours of safety engineers with the division superintendents afford opportunities to improve morale. Periodically they visit the stations, tank farms, field batteries, and maintenance and construction jobs to inspect safety equipment and check for hazards. Their fresher perceptions often detect unsafe conditions unnoticed or tolerated by the local personnel. The safety engineers are able often to bolster any flagging morale of supervisors and workers on isolated jobs through friendly discussion.

First-aid training classes are especially fine media for making company boosters, Mr. Farrell pointed out. The training technique prescribed by the U. S. Bureau of Mines is followed. The training is taken voluntarily by employees on their own time. It is offered to them every other year.

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources: i.e. (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

Personal safety contests provide the means for reducing absenteeism, he said. These instill a competitive team spirit not only in preventing accidents but also in keeping the workers on the job. Whether or not a minor injury results in lost time usually depends on employee attitudes. One injured worker may elect to lay off a few days whereas another hurt even more seriously will continue at work through the competitive urge and the concern of his fellows as well as his own for their team safety record. A company-wide record of but one lost-time injury out of every nine accident cases exemplifies the idea.

Probably some managers have overlooked safety programs, Mr. Farrell stated, because they still think of safety too much in terms of fire extinguishers, machine guards, "hard-hats," and other gadgets to be improved by their engineers. Even with such safeguards galore, it has been found that safety is a mental attitude that can be best improved by human engineering. Thus, he declared, safety promotion is largely a matter of training, and fits hand in glove with modern programs of employee training and good-will building.

A manager or superintendent uses poor judgment who makes of his safety engineer a mere junior who must look to safety engineers in other firms and to the National Safety Council for guidance and inspiration. Men who can be as valuable as these in promoting so many phases of the company work merit the status of senior assistants. As such, they should be encouraged to offer advice in the formulation of personnel policies and the planning of new jobs, as well as in the execution. Shell's own safety engineers and first-aid instructors have had practical pipe-line experience and have been selected for their judgment and personality. They are well qualified to represent the area or head office managements in the field, and to safeguard the personal welfare of the workers with whom they are associated.

Employee training, good-will building, and safety promotion are logical parts of the industrial-relations program. In fact, Mr. Farrell said, they should be predominant parts.

Smog Prevention

IF factory stacks emitting waste gases were built 300 to 400 ft or more in height they might help considerably in preventing the accumulation of "smog" around factory areas, according to Dr. Morton L. Barad, meteorologist of the General Electric Company, Schenectady, N. Y.

Dr. Barad, of the Hanford Works in the state of Washington, operated by G. E. for the Atomic Energy Commission, reported to a recent New York meeting of the American Meteorological Society on his studies of temperature changes in fogs. These indicate a possible mechanism by which factory smokes and gases may combine with fog to form smog in strong concentrations at ground level.

Part of the meteorological equipment at the Hanford Works is a tower 410 ft high. This is equipped to measure the temperature, wind direction, and wind speed at a number of different levels from the ground to the top. Dr. Barad has recently analyzed data obtained with this tower during three different fogs.

He finds that in each case, just before the fog formation, the temperature near the ground increased with elevation. A few hours later, after the fog had formed, these conditions were reversed. Then the temperatures dropped slightly in approximately the first hundred feet. For about the next two hundred feet they remained approximately constant, while at the top of the tower, for about a hundred feet, temperatures increased again.

Dr. Barad pointed out that this has an important application to problems of air pollution. If stack gases are discharged at heights of less than a few hundred feet, below the upper regions where the air gets warmer with altitude, they will tend to settle toward the ground, he said. This is because, during the period of fog, there is gentle vertical spreading of smoke in the air in these lower layers.

Thus, he said, it may be that with stacks high enough to get the emitted gases to the height where temperature is increasing, such settling of smog would not occur.

If this proves to be correct, said Dr. Barad, the information will be important not only for the alleviation of pollution problems with us now but also for the prevention of pollution problems in the future.

611-Ft Chimney

A 611-FT-HIGH chimney, said to be the world's tallest, was completed in October, 1950, for the El Paso, Texas, plant of the American Smelting and Refining Company. This reinforced-concrete structure, which is described by Arthur M. Clark, an assistant engineer with the Custodis Construction Company, Inc. of New York, N. Y., in the February, 1951, issue of *Civil Engineering*, has an internal top diameter of 14 ft

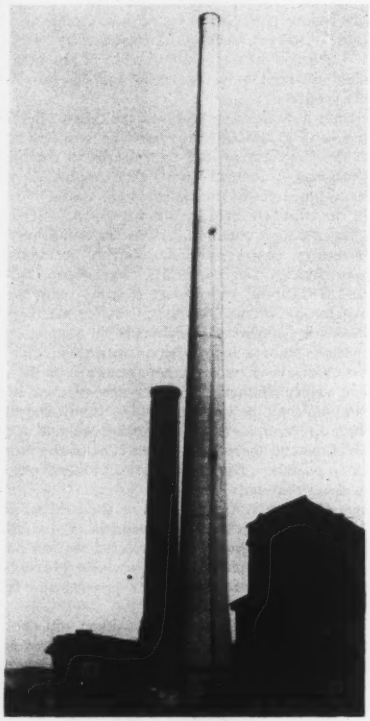

FIG. 1 NEWLY COMPLETED 611-FT REINFORCED-CONCRETE CHIMNEY TOWERS ABOVE OLD 250-FT BRICK CHIMNEY

(New structure has dual purpose of providing better draft and minimizing nuisance under unfavorable atmospheric conditions.)

0 in., and is used to discharge the gases from six Dwight & Lloyd sintering machines used in the refining of lead ore. It replaces a smaller 250-ft common-brick chimney.

Between the sintering machines and the chimney the gases pass through a spray chamber and a large baghouse which removes most of the solids. The function of the spray chamber is to reduce the gas temperature to below 200 F so that the woolen bags will not be damaged. The tall chimney was required to provide sufficient draft on the baghouse, which heretofore had been lacking. Also, the height of the chimney greatly minimizes any chance that the gases, which contain approximately $^1/_2$ of 1 per cent of sulphur dioxide, will become a nuisance under unfavorable atmospheric conditions.

The specifications called for the chimney shaft to be designed in accordance with Specification 505-36T of the American Concrete Institute, titled "Tentative Specification for the Design and Construction of Reinforced Concrete Chimneys," which has been the basis for the design of practically all large reinforced-concrete chimneys built in North America in the past 15 years. For design purposes, the wind force on the chimney was specified as a uniform pressure of 33 psf on the entire vertical projection. A maximum gas temperature of 300 F and minimum atmospheric temperature of 30 F were specified as design criteria, although under average operating conditions gas from the baghouse is discharged into the chimney at approximately 180 F.

The chimney shaft is tapered from top to bottom, the increment of increase in the outside diameter varying from $2^5/_8$ in. per 10 ft of vertical height in the upper part to $8^5/_8$ in. per 10 ft of vertical height at the bottom. The bottom outside diameter is 44 ft 10 in. Wall thicknesses at the top and bottom are 9 in. and 25 in., respectively. At the extreme top, the wall is offset 3 in. on the outside, and the maximum wall thickness is 27 in. at the bottom of the flue opening, where additional wall thickness and extra reinforcing steel are required to compensate for the opening.

Vertical reinforcing, designed for the combined effect of dead load, wind load, and vertical temperature effect, increases from 50 $^1/_2$-in. round bars at the top, to 202 1-in. round bars at the bottom of the shaft. The horizontal reinforcing, designed for diagonal tension and horizontal temperature effects, consists of $^3/_4$-in. round bars spaced 6 in. on centers directly above and below the flue opening; $^5/_8$-in. round bars spaced 6 in. on centers between the top of the foundation and the flue opening, and also for the height of the opening itself; and $^1/_2$-in. round bars spaced 6 in. on centers for the remainder of the shaft. The chimney shaft contains 2394 cu yd of concrete and 142 tons of reinforcing steel, and its dead weight above the foundation is 4885 tons.

At average operating conditions of 180 F gas temperature and 60 F atmospheric temperature, the chimney provides a theoretical draft of 1.05 in. water at the flue dampers and has a capacity of 285,000 cu ft of gas per min.

Diesel-Engine Research

A REVIEW of Diesel-engine development, based on the work at the Diesel Research Laboratory of Caterpillar Tractor Company, Peoria, Ill., was presented in a paper by Carl G. A. Rosen, Fellow ASME, a consulting engineer with Caterpillar, which he gave as the 1950 James Clayton Lecture to The Institution of Mechanical Engineers (Great Britain).

Mr. Rosen stated that for many years intensive effort has been made to understand the combustion process in this type of engine by a better knowledge of the fundamentals of ignition and the mechanism of the combustion process, and this study has been developed in the laboratory on a competitive basis. Originally six combustion systems were put to trial and a modified precombustion-chamber engine won the palm of victory on the basis of its ability to maintain uniformity over extended periods of operation.

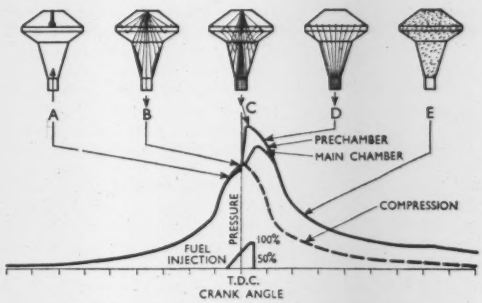

FIG. 2 COMBUSTION IN PRECOMBUSTION-CHAMBER ENGINES
(A, Start of injection: air flowing into chamber; B, Ignition: fuel build-up on chamber throat walls; C, High pressure: fuel-air mixture flows from chamber; D, Injection ends: most of fuel transferred to main chamber; E, End of combustion: residual products.)

Briefly, the character of the comparative combustion studies followed two general classifications: (1) visual combustion studies; (2) study of combustion-chamber deposits.

In order to make extended studies of the combustion phenomena by visual means, a quartz window was designed to achieve maximum cleanliness without the distraction of soot condensation on the cold windows.

In describing the precombustion-chamber process, Mr. Rosen dealt with the composition of combustion gases, flame duration, temperature distribution, the mechanism of ignition, and combustion-chamber deposits. He also discussed the development of fuel-injection equipment, pretiming, precalibrating, and the evolution of the fuel pump. He described the characteristics of several types of check valve and fuel valve, and the fuel-pump control of engine torque characteristics. Spray characteristics and the flow through the fuel-valve-orifice were also examined. He commented upon materials for cylinder liners and piston rings, and the effect of fuel inclusions on cylinder wear; lubrication was also considered.

The development of the precombustion-chamber principle of combustion has not yet reached its limit of progress, Mr. Rosen concluded. Avenues of advance open for progressive strides toward the horizon of probability in higher ranges of output and higher zones of speed with reasonable maintenance are as follows:

1 Control of the flame front of the gas-injected combustibles, to prevent destructive concentration of heat flow through metals.

2 Equalization of heat transfer through the main combustion-chamber envelope, to relieve cylinder head and piston structures of undue mechanical and thermal stresses.

3 Use of two-stage supercharging, a primary crankshaft-driven centrifugal blower, and a secondary exhaust-driven turbosupercharger.

4 Continued improvement of materials and lubricants.

5 Provision for controlled thermal levels throughout the geometry of the engine, to stratify temperature ranges, for maximum efficiency and effective cooling.

6 Improvement in starting.

Mr. Rosen's paper will be published in full in a forthcoming issue of the *Journal* of The Institution of Mechanical Engineers.

20th Century Rocket Research

THE rockets of 1900 were basically not much different from those developed centuries earlier, according to Joseph W. Siry, writing in *The Scientific Monthly*, December, 1950. Mr. Siry's article on "The Early History of Rocket Research," appeared in the November, 1950, issue of *The Scientific Monthly*, and was abstracted in the February, 1951, issue of MECHANICAL ENGINEERING. In this second article on "Rocket Research in the Twentieth Century," Mr. Siry points out that at the turn of the century a fundamental change was wrought in the conception of the rocket. Serious consideration began to be devoted to the rocket as a possible means for conducting scientific experiments at very high altitudes, and ultimately as a vehicle for space travel. R. H. Goddard and K. E. Ziolkovsky were among the first to apply modern scientific methods in an effort to achieve the realization of these dreams.

Ziolkovsky, a Russian mathematician, published a number of articles relating to rockets and space travel at the beginning of this century.

Dr. Goddard's early theoretical calculations indicated that the rocket would be a valuable upper-atmosphere research tool provided that sufficiently large values of the mass ratio and exhaust velocity could be achieved. His experiments were the first in which the mass ratio and the exhaust velocity received due consideration.

FIRST LIQUID-FUEL ROCKET

In 1920 Dr. Goddard began a series of experiments with liquid fuels under a grant from Clark University, where he was then professor of physics and director of the Physical Laboratories. The world's first liquid-propellant rocket was launched by Dr. Goddard on March 16, 1926, on a farm at Auburn, Mass.

The tests continued there until July 17, 1929, when neighbors mistook a rocket flight for an airplane crash, and the apparatus was moved to the artillery range at nearby Camp Devens. Various methods for injecting fuel and cooling the combustion chamber were tested there during the next year. Dr. Goddard developed the film-cooling principle and a variation of regenerative cooling technique during this period. He obtained effective exhaust velocities of well over 5000 fps. The flight of July 17, 1929, brought the work to the attention of Daniel Guggenheim, who agreed to finance the studies for a two-year period, making it possible to transfer operations to an ideal location near Roswell, N. Mex., within V-2 range of the present White Sands Proving Ground. Dr. Goddard's modest research installations soon developed into a small-scale model of the White Sands establishment, complete in almost every detail. In fact, a number of the fundamental principles employed in the rockets now fired at White Sands were first developed and tested by Dr. Goddard.

The depression interrupted the New Mexico program in 1932, and Dr. Goddard returned to Clark University. While there he began the development of rocket fuel pumps and devised an apparatus that was the forerunner of the modern ramjet.

Dr. Goddard returned to New Mexico in 1934, and the flight-testing program was resumed; and on May 31, 1935, a rocket rose to a height of 7500 ft, the highest altitude ever reached by a rocket up to that time.

Dr. Goddard's emphasis upon fundamentals bore fruit again in the rocket tested on July 28, 1937. This missile was steered by appropriately altering the direction of the axis, and hence also of the thrust of the rocket motor. This same control principle is now employed in the Viking, the Navy's new upper-atmosphere research rocket.

From 1938 to 1941 Dr. Goddard developed several different types of fuel pumps. Some were driven by gas generated in a small auxiliary combustion chamber that burned the primary rocket fuels. Others were powered by gas drawn directly from the main combustion chamber.

During World War II Dr. Goddard conducted confidential rocket research at the Naval Engineering Experiment Station at Annapolis. His death on August 10, 1945, brought an untimely end to one of the outstanding careers in the history of rocket research.

For more than a decade Dr. Goddard was almost alone in the field. Interest in rockets gradually became more widespread, however, and during the post World War I period it crystallized when rocket societies were formed such as the "Verein für Raumschiffahrt" (Society for Space Travel, often known by the initials VfR), founded in Germany in 1927, and the American Interplanetary Society, now known as the American Rocket Society, founded in New York in 1930.

VFR AND THE RAKETENFLUGPLATZ

Work was begun in the VfR by a small nucleus of the membership, which totaled almost 1000. The first attempts were aimed at producing an operable liquid-fuel rocket which was to be of the smallest possible size in order to conserve funds. It was called the "Minimumrakete," which was abbreviated to "Mirak." Rudolph Nebel, who had worked with Hans Oberth in the abortive "Kegeldüse" development, proposed the Mirak idea and built the first model. The first Mirak was tested by Nebel and Klaus Riedel, but exploded during one of the experimental runs.

Instead of choosing a site in a remote section of the continent, the VfR established its "Raketenflugplatz" (rocket airdrome) in Berlin. The second Mirak was tested there. It, too, exploded during one of the static tests.

Several motors were developed, including the regeneratively cooled, liquid-oxygen, alcohol motor. The latter, when tested in the spring of 1932, developed a thrust of a little more than 130 lb.

The deepening economic depression and the schisms within the VfR that accompanied Hitler's ascendancy had an atrophic effect upon the research program. The gradual decline was climaxed when the Gestapo seized the files and dispersed the remnants of the Raketenflugplatz personnel.

European rocket activity during this period was not concentrated entirely at the Raketenflugplatz. Actually, the first liquid-fuel rocket to be flown successfully in the eastern hemisphere was launched by Johannes Winkler, who had preceded Oberth as president of the VfR. It took off on March 14, 1931, almost five years after Dr. Goddard's first flight. This rocket was only about 2 ft long and weighed 11 lb; nevertheless, it attained an altitude of approximately 2000 ft.

Interest in powder rockets continued during this period. Reinhold Tilling conducted tests with his winged powder rockets in the spring of 1931.

The German Army set aside a portion of its artillery proving grounds at Kummersdorf for powder-rocket research under Captain Walter Dornberger. In the fall of 1932, after witnessing a highly successful demonstration flight of one of VfR's one-stick repulsors, army officials widened the cognizance of Dornberger's unit to include liquid-fuel-rocket studies.

Their first rocket, which had the code name Aggregate No. 1, or A-1, was built in 1933. It was redesigned, designated the A-2, and flight-tested in 1934. Powered by a liquid-fuel motor delivering a 660-lb thrust, it reached an altitude of 6500 ft.

The A-2 was about 1 ft in diam, 55 in. tall, and weighed approximately 330 lb at take-off. This included the stabilizing gyroscope, which weighed about 90 lb, and approximately 90 lb of fuel.

PEENEMUNDE AND THE V-2

Larger motors were developed, and the program soon outgrew the facilities available at Kummersdorf. Accordingly, an obscure insular location, along the Baltic Coast, at the village of Peenemünde was selected as the site for the new research establishment. Construction was begun in the summer of 1936. Two separate stations were built, Peenemünde-Ost, for the army, and Peenemünde-West for the air force, at a cost of about $75,000,000.

The scale of the operations at Peenemünde was reflected in its first product, the A-3, which was 25 ft long, 30 in. in diam, and weighed 1650 lb. The motor developed a thrust of 3300 lb and operated for 45 sec. The A-3 resembled the V-2. Steering was accomplished by means of jet vanes. Flight tests of the A-3, and a similar model designated A-5, were conducted in 1938. Altitudes of 40,000 ft were attained with these missiles.

A large supersonic wind tunnel was put into operation at Peenemünde in 1939. When data from this instrument became available, the design and construction of a much larger rocket were undertaken. The first flight test of the new model, the "Fernrakete" A-4 (long-range rocket A-4), took place on July 6, 1942. The rocket reached an altitude of one yard and then exploded. The second A-4 reached an altitude of three miles before it exploded. A successful flight was not achieved until the fourth A-4 was fired on October 3, 1942. After more than 100 firings and much development work, 15 to 20 per cent of the A-4's were still failures.

Many of the A-4's shortcomings still remained to be remedied when the "Waffen-SS" took control of the program following the attempt on Hitler's life on July 20, 1944. A few weeks later the first A-4 was launched against London as "Vergeltungswaffe Zwei" (Revenge-Weapon Two), or, simply, V-2. The V-2 was capable of carrying a one-ton warhead to an altitude of 100 miles or to a range of about 200 miles.

The chief significance of Peenemünde from the rocket-research standpoint lay in the fact that, for the first time, a modern, large-scale, co-ordinated rocket-research and development effort was undertaken.

AMERICAN ROCKET SOCIETY

In 1931 the American Rocket Society began its research program. Static tests of rockets and rocket motors were made in a number of different suburban locations in New Jersey and Westchester. Flight tests were conducted on the Staten Island shore of Lower New York Bay. The early work was similar in many respects to that of Dr. Goddard and the VfR.

The group's principal flight occurred on Sept. 9, 1934, when a speed of about 700 mph was attained by a rocket designed by John Shesta.

In 1936 the first International Astronautical Award to honor American work was given ex aequo to the American Rocket Society and to Alfred Africano, one of its members.

James Wyld's design for a regenerative motor was published in *Astronautics* in 1938, and the motor was first tested in December of that year. It produced a thrust of more than 90 lb and a jet velocity of 6000 fps. More powerful motors followed, and a motor designed by Africano registered a thrust of over 260 lb.

In 1941 four members of the Society formed Reaction Motors, Inc., to develop rocket-propulsion equipment for the Armed Forces. During the war RMI developed rockets for use in jet-assisted take-off applications.

A rocket-research program was begun in 1936 at the Guggenheim Aeronautical Laboratory of the California Institute of Technology. The experimental work of the GALCIT group was integrated with an exceptionally fruitful theoretical program. In 1940 the Jet Propulsion Laboratory was established at the California Institute of Technology, undergoing considerable expansion during the war.

American rocket research in World War II began in the summer of 1940. The establishment of Section H in Division A of NDRC resulted. Other units subsequently were formed under NDRC. CIT provided the nucleus of the principal rocket-research center that came under this program. Work was also done at the Allegany Ballistics Laboratory, in western Maryland, which was operated by George Washington University.

Rockets were employed by most of the combatants in a wide variety of tactical and strategical situations. The Bazooka enabled the infantryman to defend himself effectively against the tank. The tank itself was sometimes equipped with elaborate rocket-barrage apparatus. Rockets also were used both offensively and defensively in aerial warfare.

Guided missiles were among the most spectacular developments to come out of World War II. The hard-pressed Germans developed a variety of rocket-propelled missiles intended for use against air-borne and surface targets. One of these was the Hs 293, which was launched against Allied vessels. The "Schmetterling" was an antiaircraft missile which probably would have become the V-3.

UPPER-ATMOSPHERE RESEARCH WITH ROCKETS

At the time of Dr. Goddard's death the GALCIT Jet Propulsion Laboratory was already engaged in developing the Army's Wac Corporal for upper-atmosphere research. The Wac Corporal attained an altitude of 44 miles; however, it fell short of meeting the needs of the postwar upper-atmosphere-research programs. Accordingly, the development of a larger version, known as the Aerobee, was begun under Navy sponsorship. Even the martial V-2 was harnessed for peaceful purposes. The Viking, a rocket designed to serve the upper-air-research program more effectively, was also initiated by the Navy.

The use of this variety of high-altitude vehicles for scientific exploration is co-ordinated by the Upper Atmosphere Rocket Research Panel.

The Aerobee is 15 in. in diam, 20 ft long, and weighs about half a ton. Payloads of up to 250 lb can be carried in the instrumentation section, which occupies the forward 88 in. of the fuselage. The Aerobee is launched from a tower. After it leaves the tower it is stabilized aerodynamically by the action of its tail fins, and the trajectory is controlled by tilting the tower appropriately. Launching is accomplished with the aid of a solid-fuel booster rocket, which imparts a velocity of about 1000 fps. The booster than drops away, and the liquid-fuel motor of the rocket proper operates for about 45 sec. The Aerobee has reached a maximum velocity of approximately 4000 fps and an altitude of about 78 miles.

The Viking power plant uses liquid oxygen and alcohol as propellants and develops an effective exhaust velocity of about 6500 fps and a thrust of 10 tons. Fuel-injection pressure is generated by a turbopump, which is driven by the decomposition of hydrogen peroxide. The Viking is steered by appropriately altering the direction of the rocket-motor axis. This is another of the many techniques developed by Dr. Goddard. The Viking is now 48 ft 7 in. tall, 32 in. in diam, and weighs more than five tons when fueled. The forward compartment of the rocket, 102 in. long, is reserved for upper-atmosphere-research instrumentation, and additional space for

this purpose is available in other parts of the missile. The Viking can carry pay loads ranging from 100 lb to a ton. With a 100-lb pay load it has a propellant mass ratio of about 0.75, the highest ever achieved. It is the first American rocket to attain an altitude in excess of 100 miles.

An adequate understanding of the earth's upper atmosphere cannot be had without knowledge of its behavior at different times in the diurnal and annual cycles and at a number of important regions around the globe. One method of attacking the latter problem is to utilize ships as mobile launching platforms. Such a program has actually been inaugurated. Aerobee and Viking rockets have been fired from the deck of the U. S. S. *Norton Sound* at a number of key locations in the Pacific Ocean.

The high-altitude research program contributes to rocket development in several ways. It makes known many essential facts about the regions through which rockets travel. Radio telemetering systems such as those developed by the Naval Research Laboratory and the Applied Physics Laboratory for use in upper-air studies, have also proved their value as rocket research tools. They have been used to study the performance of rockets such as the V-2, the Aerobee, and the Viking during actual flights on numerous occasions.

Sun Follower

AN important phase of the Air Force's Upper Air Research Program was completed recently with the maiden flight of a sun follower used in the instrument section of an Aerobee rocket, it was reported in the CADO *Technical Data Digest*, for February, 1951. The firing was conducted at Holloman Air Force Base at Alamogordo, N. M., by scientists of the University of Denver under contract to the Air Force's Cambridge Research Laboratories.

The sun-follower is designed to point an ultraviolet spectograph which separates light into different wave lengths so that each wave length can be studied individually. Designed and constructed by the University of Denver, the spectrographs help scientists to learn more about the physics of the upper atmosphere.

A servomechanism, controlled by the sun follower, rotates a portion of the rocket's nose cone to maintain a fixed orientation with respect to the direction of the sun. The spectrograph is pointed at right angles to the sun's rays by the follower. Spinning, vibration, and wavering of the rocket during its upward flight did not affect the operation of the instrumentation adversely.

Prior to actual field tests, the sun follower was thoroughly tested in the University's Upper Air Laboratory. Several different testing machines were designed and constructed for the project.

A vibration tester was built, which is capable of vibrating the entire rocket nose cone at any frequency up to 80 cps. This device revealed any structural weaknesses due to resonance conditions in the vibrations of the rocket in flight.

Two acceleration testers were designed to test the structure of the sun follower where parts are vulnerable to the forces produced in the acceleration of the rocket. Both machines are capable of producing an acceleration 30 times as great as the acceleration of gravity.

A centrifugal acceleration tester was built to test the smaller parts of the enclosed servo system. This was done by rotating the individual parts at the required speed in a revolving bucket arrangement.

Another machine, the drop gravity tester, was built to test structural weaknesses in the entire assembled equipment.

Still another tester, the servo response tester, was designed to test the ability of the servo system to keep the spectrograph aimed at right angles to the sun's rays.

Automatic Lubrication

OF THE many types of textile machinery, spinner and twister frames present a lubrication problem which is urgently in need of a solution through an improved method of applying lubricant to the rings and travelers utilized in the twisting and spinning processes. This fact was brought out by L. C. Rotter, Mem. ASME, and B. S. Davis of the Lincoln Engineering Company, St. Louis, Mo., at a Textile Division Technical Session during the 1950 ASME Annual Meeting.

They pointed out that a survey of textile mills using these frames disclosed that there was no standard practice or consistency as to type of lubricant used. It was also found that the manual method of applying the lubricant was still in use in most of today's textile mills, and that this method not only reduced yield and increased operating costs of the machinery, but in many cases reduced efficiency of the machines because of inadequate and improper lubrication.

To insure proper lubrication, the authors said, controlled application is essential, and can be assured through the use of an automatic centralized lubrication system. See Fig. 3.

The system comprises a power-operated lubricant pump, pneumatically or electrically actuated, which supplies lubricant, either oil or grease, from the original refinery container through a single supply line to a circuit of lubricant injectors or metering valves. Each injector is connected to a ring by means of copper or flexible tubing. Injectors operate by positive displacement, actuated by the supply-line pressure, a discharge lubricant to each ring at the line pressure. Injectors are adjustable externally, so that each ring may receive a measured amount of lubricant—no more, no less, while frame is in operation. The lubricant pump is equipped with an automatic time-clock device having adjustable frequency settings which permits setting the time interval for complete lubrication cycles from minutes to hours, as required. The frequency of the lubrication cycle, as selected, is manually set on the time clock. Lubrication cycle is started by closing electrical circuit on time-clock panel. The time clock automatically energizes lubricant pump. Lubricant, under pressure, is forced through the supply line, discharging predetermined quantities of lubricant from the injectors at line pressure. Injectors automatically recharge when pressure is relieved in supply line, completing the lubrication cycle. As a safe feature, some time clocks used

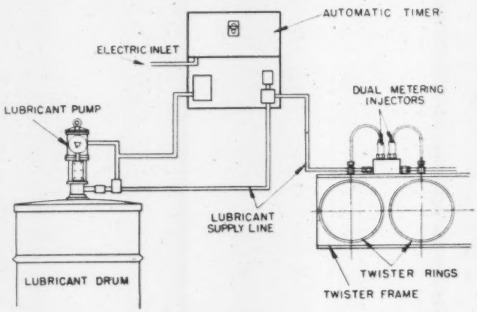

FIG. 3 AUTOMATIC CENTRALIZED LUBRICATION SYSTEM FOR SPINNER AND TWISTER FRAME

in this system incorporate a signal alarm which automatically warns when lubricant supply in refinery container is low.

This centralized system need not be limited to one twister or spinner frame. Some installations include as many as 20 frames in which the circuit of injectors on each machine are connected into a header line from one centrally located pump with time-clock control panel.

Computing Machines

Maddida

MADDIDA (Magnetic Drum Digital Differential Analyzer), a new small electronic computer, designed and built for the Experimental Towing Tank at Stevens Institute of Technology, Hoboken, N. J., by Northrup Aircraft, Inc., Hawthorne, Calif., was demonstrated in New York, N. Y., during the recent annual meeting of the Institute of Aeronautical Sciences.

The Maddida is said to be capable of solving any type of ordinary differential equation—or any simultaneous set of such equations. The computer arrives at its answers by counting electronic impulses.

This first production model of the machine will be used at Stevens for predicting the best designs for ship hulls, and for stability and control investigations on hydrodynamic bodies, including anything that moves in and on the water, such as torpedoes, underwater rockets, submarines, ships, PT boats, and flying boats.

However, Northrup is now manufacturing Maddida for general use in science and industry. Its relatively low cost brings the device within reach of many organizations which previously found the costs of computers prohibitive.

Requiring only one untrained operator, the computer is contained in a metal cabinet of standard desk height. It is 31 in. high × 21 in. wide × 54 in. deep and weighs approximately 400 lb.

Maddida contains approximately 100 vacuum tubes, exclusive of the power supply and read-out equipment. Its power load is approximately 30 amp at 110 volts, 60 cycles.

Maddida's 44-integrator capacity enables it to pick up and add binary digits at approximately 100,000 per sec. The largest number it can handle is 29 binary digits, comparable to about 9 decimal digits. Twelve input and 12 output channels in Maddida lead to the computer's "eyes and ears," auxiliary devices which can pick up information from 12 tapes simultaneously. The machine can plot six graphs or type out on 12 printers simultaneously as it computes. Maddida's magnetic drum "memory," only mechanical moving part on the computer, can store up thousands of binary digits, then select them as needed during its problem solving. One distinct advantage of this machine, it is pointed out, is that in setting up a problem to be solved, differential equations need not first be reduced to difference equations as is done with other types of digital computers. The differential equations may be taken as they stand and coded for the machine in a very rapid and straightforward manner.

Colleges or universities should find uses for this instrument in the department of mathematics, as a differential type of computer; in electronic or computer design courses as a laboratory training tool; and in postgraduate groups to solve research problems.

In engineering firms and engineering departments of large industrial firms, the computer can be used for the solution of complex problems in engineering design, such as stresses in large structures, vibration and windload calculations, and heat-transfer problems.

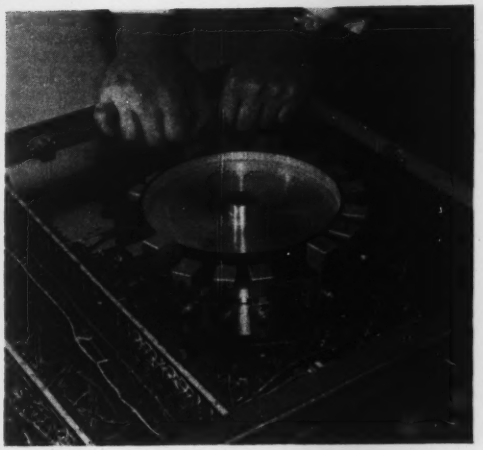

FIG. 4 NERVE CENTER OF MADDIDA, NEW ELECTRONIC COMPUTER, IS THIS METAL "MEMORY," A RAPIDLY REVOLVING DRUM WHICH CAN STORE UP ABOUT 10,000 NUMBERS, USING THEM WHEN NEEDED IN THE COMPLICATED EQUATIONS WHICH THE MACHINE IS CAPABLE OF SOLVING

(The numbers are reported on Maddida's metal memory through electronic pulses, and are kept on tab until needed. During the process of arriving at an answer Maddida digs into the memory circuit and lifts out the number or series of numbers needed for a solution. This drum is the only moving part on the new electronic computer.)

The aviation industry can employ Maddida for solving complex aerodynamic problems, aeroelastic problems of wing and body design, flutter and vibration problems, stress and structure analysis.

And in industry the instrument can be harnessed to solve industrial control problems, such as production control, quality control, direct continuous control of chemical or physical processes, and general research such as heat or fluid flow and its controls.

Government Computer Program

THE interest of the U. S. government in the computing-machine program in this country was discussed by Mina Rees, mathematical sciences division, Office of Naval Research, Washington, D. C., in the December 22, 1950, issue of *Science*.

ANALOG COMPUTERS

According to Miss Rees, although the substantial government interest is, and has been for some time, in the digital field, it would be false to give the impression that no considerable sums of money have been invested by the government in analog computers. She mentioned in particular the Reac, developed by the Reeves Instrument Company under a Special Devices Center contract for the Office of Naval Research. This is an electromechanical machine which has been used at Reeves on problems submitted primarily by aircraft companies, and dealing with the design of guidance and control systems, with stabilization, with the dynamics of the combustion process, and with related problems. Goodyear Aircraft, under an Air Force contract, has developed a similar machine.

Reac machines are available commercially, and more than 60 are in use at industrial and government laboratories. In many cases changes and adaptations of the machine have been made to make it more suitable for the problems of the local laboratory.

Other machines of the differential-analyzer type, which are electronic and thus attain greater speed, but with somewhat less accuracy, have been built in the Research Laboratory of Electronics at M.I.T., and by George A. Philbrick Researches.

Other analog machines, such as the flight simulator at M.I.T., have been sponsored recently, under direct government contract; and the biggest differential analyzer of them all, Typhoon, has been dedicated recently.

Some important analog machines such as the Anacom at Westinghouse have been developed by commercial companies and universities. All these machines, and others too numerous to mention, are proving their usefulness, and are enthusiastically supported by their users. Some, such as Professor McCann's machine at California Institute of Technology, built without government support, sell their time.

One machine which the Office of Naval Research has sponsored, and which Prof. Raymond Pepinsky described over a year ago, is being used extensively at Penn State College for the analysis of crystallographic structure problems.

A rough basis for the selection of an appropriate type of machine to perform a given computation was also given by Miss Rees. In problems involving differential equations, she said, the electronic differential analyzers seem particularly suitable for a very fast survey of the results obtained as relatively few parameters are varied; the Reac and the Goodyear type of machine are intermediate in the number of parameters handled and in accuracy; whereas the digital machines, when fully exploited (and when and if the programmers and coders exist for their proper use) will in many cases permit more inputs and yield greater accuracy.

GOVERNMENT DIGITAL MACHINES

Regarding digital machines of interest to government agencies, Miss Rees pointed out that the Army Ordnance Department and the Navy Bureau of Ordnance were the pioneers in this field and are jointly responsible for the extensive array of machines now at the Ballistics Research Laboratory at Aberdeen, and for the machines at the U. S. Naval Proving Ground at Dahlgren. Moreover, the Army Ordnance Department sponsorship of the automatically sequenced high-speed electronic computer at the Institute for Advanced Study has inspired designers in the development of digital computers, and has actually given rise to groups that are copying the machine nearing completion. IBM, too, has contributed importantly to the development of the digital computer art. This company's collaboration with Prof. Howard Aiken at Harvard in the building of the Mark I represented only one phase of its contribution.

After World War II the concern to exploit the potentialities of digital computers for the benefit of Federal governments that were not engaged extensively in military activities was expressed first by the desire of the Census Bureau to obtain a machine suitable for its use in the 1950 census. Actually the census machine is not yet available to the Census Bureau but some census problems are being run on the Seac now at the Bureau of Standards.

Other Federal bureaus, including the Office of Naval Research, were happy to use the services of the Bureau of Standards as a purchasing and monitoring agency, she stated, and thus the machine development section of what later became the Bureau's National Applied Mathematics Laboratories came into existence

Outside the program monitored by the Bureau of Standards, the Office of Naval Research has had a very limited program in support of electronic digital computers. In particular, ONR is giving partial support to the so-called Caldic at the University of California in Berkeley. Careful plans have been drawn for this machine, and drawings and design information will be available to small research centers that need an installation on the spot.

In line with these objectives, a magnetic-drum memory having a storage capacity of 10,000 nine-decimal digit numbers, has been completed.

Howard Aiken has recently emphasized the desirability of having a relatively simple and cheap machine available to small universities. Professor Morton, the designer of the Caldic, estimates that the cost to reproduce this machine in a university laboratory is under $50,000.

PRESENT STATE OF THE COMPUTER ART

Miss Rees then summarized briefly the recent changes in the state of the computer art. Several electronic digital computers, including the Seac (the Bureau of Standards Eastern Automatic Computer) and the Swac (the Bureau of Standards Western Automatic Computer), she reported, have been assembled during the past year and are under test, and others are almost entirely assembled.

The Edvac, the Binac, and the Seac are the acoustic computers completed thus far in this country, and a Univac and a Raytheon computer should be completed within the year.

The Eckert-Mauchly Computer Corporation, designer of the Univac, has recently stepped up production schedules; one complete system is being assembled, and parts of another are ready for assembly.

The National Bureau of Standards Seac, is a general-purpose electronic digital computer. The machine has been so designed that both the serial-type acoustic and parallel-type electrostatic memories can be used simultaneously, and provision has been made for possible increase of the combined memory capacity up to 4000 words.

The principal general-purpose computers with magnetic-drum memory are the Aiken Mark III, which is being reassembled after being moved from Harvard to Dahlgren, and a computer on order for Wright Field under contract with the Bureau of Standards, which was designed and is under development in the laboratory of the General Electric Company at Syracuse, N. Y.

The principal machines using an electrostatic memory are the von Neumann-Bigelow-Goldstine machine at the Institute for Advanced Study (and its descendants in various other places), Whirlwind at M.I.T., and the Swac. The Institute for Advanced Study computer is virtually assembled.

For Whirlwind a specially designed electrostatic storage tube has been developed. The final memory is expected to be composed of 32 tubes, each storing 1000 binary digits.

The Swac has recently been dedicated at the Institute for Numerical Analysis in Los Angeles. It is hoped that the storage in each tube can be increased so that the memory capacity will become 1000 words.

FUTURE

We are now entering the period when attention is being given to the building of special-purpose digital machines, Miss Rees revealed. Already Northrop Aircraft, Inc., has developed the Maddida, a digital differential analyzer using a magnetic-drum memory. See page 325.

The Department of the Air Force is planning to ask the Bureau of Standards to design a machine especially adapted to the

determination of optimum programs for the Air Comptroller. This machine must be capable of handling extremely large matrix problems. In addition, the Air Force is planning to study the special requirements of its statistical control and statistical research centers and to proceed with development of a moderate-size machine intended for such applications.

Carrier-Borne Jet Plane

A NEW carrier-based jet fighter, designed specifically for high-altitude interception, has passed its initial flight tests successfully, the Navy disclosed recently.

While performance data were not given, the Navy released pictures which showed that the new plane, designated the XF4D, is tailless and is actually a triangular-shaped platform wing with a slim nose extending forward to provide a cockpit for the pilot.

The plane is designed to be catapulted from carrier decks and to climb rapidly to the upper atmosphere.

The Navy said the XF4D fulfilled the need for a plane that can intercept an enemy on short notice.

First flight tests were conducted at the Edwards Air Force Base, Muroc, Calif.

The XF4D was built by the Douglas Aircraft Corporation at its El Segundo, Calif., plant under the supervision of the Navy's Bureau of Aeronautics. The Navy's F3D Skynight, twin-jet night fighter, the AD Skyraider, attack plane of Korean fame, and the A2D Skyshark, turboprop carrier attack plane, are also in production at this plant.

Turbojet Engine

A NEW turbojet engine, said to be the most powerful in the world, has successfully completed ground tests that qualify it for quantity production, according to a joint U. S. Navy-Westinghouse Electric Corporation announcement. Known as the J40, the new jet uses less fuel per pound of thrust than its predecessor, the J34.

The thrust developed by the J40—equivalent to 14,000 hp at modern flight speeds—is for a "bare" engine, without thrust augmentation. The addition of an afterburner to reheat the exhaust gases, after they leave the turbine and before they emerge as a jet stream from the rear, together with other developments now in progress, is expected to almost double this figure.

A group of high-performance military aircraft, now in the prototype production stage, has been designed especially to take advantage of the performance capabilities of the new engine.

Operation of the J40 in any high-performance military plane will actually be simpler for the pilot than driving his car. The engine's electronic control system is completely integrated and automatic, from standstill to top altitude and speed. From starting to full power, and under any condition of flight or altitude, operation of the engine is accomplished with a single cockpit control, equivalent to a throttle. All engine conditions are, in turn, automatically tied to this control.

Even impossible icing conditions don't matter to the J40 for it "simply burns its own way through ice" leaving the pilot free to attend to navigation, battle tactics, and battle itself.

The J40, which was subjected to the grueling 150-hr qualification test, had already been operated more than half the required test hours before the official test started. In that time, it had run at military power almost twice as long as the test requires. Its use of lubricating oil during the test was 93 per cent less than was specified.

The J40 is of the axial-flow design. But unlike its predecessors, which take the air through a circular orifice, the air intake of the J40 is divided into two elliptical openings, arranged like the letter Y. To maintain a minimum diameter for the engine as a whole, major engine and aircraft accessories are mounted between the arms of the Y, while minor accessories are strung out along the sides of the barrel of the engine to conserve space.

The J40 also uses a unique annular combustion chamber. This annular design results in smaller combustor diameter than is possible with a number of separate can-type combustors arranged in a circle around the shaft. It also involves only a single flame, which is easier to control under difficult conditions than the multiple fires used in can-type combustors.

Although the J40 is 50 per cent greater in diameter than the J34, it produces a much greater thrust than the increase in diameter indicates. The engine is designed particularly for efficient operation at very high altitudes.

Erosion Protection

A MAJOR problem in the use of plastic laminates for nonstructural aircraft parts, such as the radar antenna housing on the F-80 jet fighter, is rain erosion during high-speed flights. This difficulty was first encountered in 1945 on aircraft operating in areas of heavy and extended rainfall. Today, higher plane speeds make the problem a more urgent one.

During the past five years the problem has been investigated thoroughly and many of the important factors which affect rain erosion have been determined, according to E. I. du Pont de Nemours & Co., Inc. Laboratory test conditions have been set up which simulate those encountered under actual flight conditions. Test equipment has been developed in which specimens are mounted on a rotating arm which whirls under a water spray. The relative performance rating of various materials of construction, as determined on this equipment, correlates well with service experience.

Studies show that of all the variables investigated, speed has the greatest effect on the rate of erosion of plastic laminates. It was disclosed that the rate of erosion increases tremendously with relatively small increases in air speed. Other factors affecting the rate of erosion are the shape or curvature of the surface of the specimen under test, the angle of attack by raindrops, and the density of the plastic laminate. Of these factors, the one which could be most easily controlled was the density of the plastic laminate. Specimens designed without surface and interior voids were found to be eight to ten times more resistant to erosion than material in which no effort was made to control the formation of voids. Despite the elimination of voids, additional protection from rain erosion was needed.

Many types of coatings were tried to protect the plastic laminate. Those made with neoprene appeared to have the best resistance. Coatings of liquid neoprene compositions bonded well to the void-free laminate and in thicknesses of about 0.010 in. gave adequate protection to the plastic material. Laboratory tests showed that a neoprene coating made the laminate 100 times more resistant to rain erosion than an unprotected one. An actual flight test showed that after 10 hr operation at speeds of 400 mph such a protected laminate was undamaged by erosion. An unprotected one, on the other hand, eroded through two to three fabric plies of the laminate in about $1^1/_2$ min during a flight at 400 mph through rain.

In addition to providing a durable, waterproof resilient coating for the laminate, the neoprene coating does not interfere with radar signal strength. Special compounding of the neoprene is necessary to secure maximum energy transmission.

The neoprene coatings are easy to apply, which means they can be used by ground crews who may not be expert painters. When the coating wears down, it can be simply built up again by spraying on more neoprene.

In actual service, the coatings have worked out so well for plastic laminated parts that they are being considered to provide protection of the aluminum leading edges of high-speed aircraft.

Magnetic Fluid Clutch

SINCE the magnetic fluid clutch was originally developed by the National Bureau of Standards in 1948, its unique features have made it the subject of extensive investigation in both Government and industrial laboratories. As a result, valuable information has been obtained on a number of problems—such as heat dissipation, settling of the magnetic powder, and hermetic sealing—which are important in industrial applications of the clutch.

Invented by Jacob Rabinow of the Bureau staff, the magnetic fluid clutch is based on his discovery that the frictional forces between solid surfaces and certain types of fluid media can be controlled by the application of magnetic fields. In its simplest form, the device consists of two parallel magnetic plates separated by a powder composed of finely divided magnetic particles. When a magnetic field is established between the two plates, the magnetic particles bind the plates against movement parallel to their surfaces.

HEAT DISSIPATION

At the suggestion of NBS, an investigation of the thermal conductivity of magnetic fluids was carried out with carbonyl iron powder "E" in USP light mineral oil. Two thousand eighty grams of iron powder were suspended in 300 grams of oil, giving approximately a 7-to-1 mixture. Four drops of polyethylene glycol oleate were added as a wetting agent. The equipment used did not permit very high flux densities, the highest being about 3400 lines per sq in. In the temperature range from 56 to 70 F, which the investigation covered, it was found that approximately 5 Btu were conducted per sq ft of cross section per deg F per in. of path length. Research conducted by the Raymond Engineering Laboratory has shown that this heat conductivity value is not affected materially by the higher flux densities.

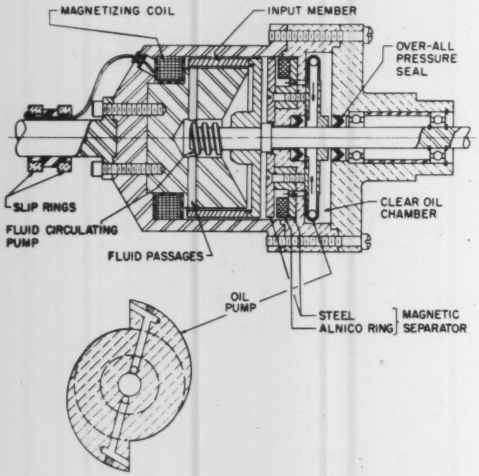

FIG. 5 DETAILED DRAWING OF NEW HERMETIC SEAL RECENTLY DEVELOPED AT NBS

[The open cylinder on the piece at left acts as the output member, a pump (center of output member) mixes the magnetic fluid and aids in the transfer of heat.]

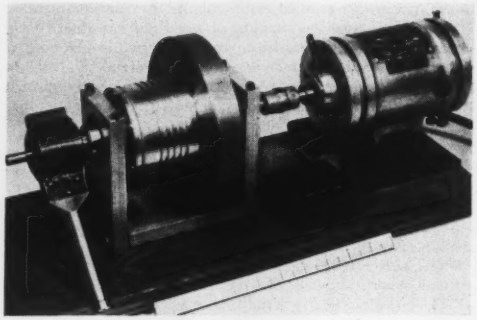

FIG. 6 HIGH-SPEED MAGNETIC FLUID CLUTCH

(In this clutch, shown at left, the outside case is made of nonmagnetic material, and the working gap is concentrated in a small annular volume just inside the outer case and enclosing the two circular pole pieces. Thus the magnetic forces are made to act against the centrifugal forces and to overcome them for high speeds.)

If a liquid lubricant is used with the magnetic powder, the mixture itself can serve as a cooling medium when the clutch is demagnetized. The lubricant can be pumped throughout the clutch so that the heat is carried away from the working gap, where it is generated, and is dissipated through the body and the shafts of the clutch. When the mixture is strongly magnetized, however, the iron particles are not mobile and it is not possible to circulate the oil through the particles freely if the quantity of iron is appreciable. This difficulty has been overcome by pumping the excess lubricant through special passages without carrying the iron powder. Centrifugal force and magnetic attraction have been used to separate the iron from the coolant.

The use of solid lubricants such as graphite has enabled some workers to operate the clutch at higher temperatures than could be maintained with oils without pressure seals. Here dissipation of heat is facilitated by the higher operating temperature of the clutch, which permits more rapid transfer of heat to the cooler surroundings.

SEALING

Several schemes have been used to keep the iron powder and the lubricant in the clutch cavity. One obvious method of doing this is to arrange the clutch in such a manner that no shaft seal is required. However, this method imposes limitations which are not always acceptable.

Labyrinth seals have been employed in magnetic clutches, with varying degrees of success. If the speed of the clutch is always high, the labyrinth can be made quite effective by utilizing the centrifugal forces on the powder. Where the speeds are variable and the positions of the clutch are undeter-

mined, as in some military air-borne applications, the use of labyrinths has not proved satisfactory.

Hermetic sealing appears to be most desirable. A satisfactory hermetic seal which was developed by the Bureau under Navy sponsorship consists of a reservoir of clear oil, mounted adjacent to the clutch proper, so designed that the clear oil is continuously pumped along the shaft into the interior of the clutch. The clear oil is then returned to the reservoir through a magnetic separator which prevents iron particles from flowing with the oil. The magnetic separator consists of a ring magnet of Alnico having a very short air gap. The iron powder does not pass the air gap, while the oil does so quite freely. An impeller-type pump then recirculates the oil back through the shaft seal. The whole system is provided with a second seal which operates entirely in clear oil. Such seals are commercially available and are quite satisfactory. Clutches sealed in this way have operated at speeds from 120 to 1440 rpm, and at slips varying from zero to 200 per cent, for 30 days with no visible evidence of iron-particle leakage. See Fig. 5.

SETTLING OF THE IRON POWDER

When the magnetic fluid clutch was first developed, it was anticipated that the settling of the iron powder during standstill periods might cause difficulties. However, as the clutch stirs itself very effectively, this has not proved to be a major source of trouble. In some applications, where the clutch serves as an overload device, or where permanent magnets are used and the clutch is never demagnetized, settling presents no problem at all.

If settling is undesirable for special reasons, it can be minimized in several ways. Thixotropic greases, which resist flow but are easily stirred, can be employed to minimize settling, or the gaps can be so designed that the iron powder is kept in essentially the right place by mechanical locks on each side of the gap. The use of wetting agents has been found to make the magnetic fluid easily miscible and to give it thixotropic properties. Where graphite is used as the lubricant, centrifugal force produces a hard-packed iron-graphite mass which stays in place when the clutch is not operating.

CENTRIFUGING PROBLEM

In some of the early magnetic fluid clutches, difficulties were caused by the pressures produced on the iron particles by centrifugal force. In fact, some clutches of this type would not release at high speed. In disk-type clutches the effect was particularly noticeable since the centrifugal pressures on the iron

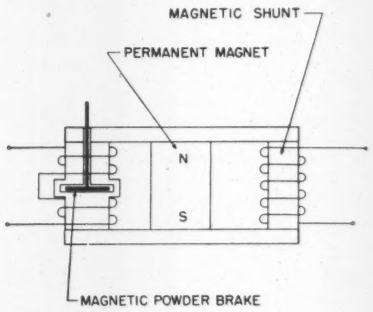

FIG. 7 TWO-WAY SHUNT SYSTEM USED WITH A MAGNETIC-POWDER BRAKE BASED ON THE PRINCIPLE OF THE NBS MAGNETIC FLUID CLUTCH

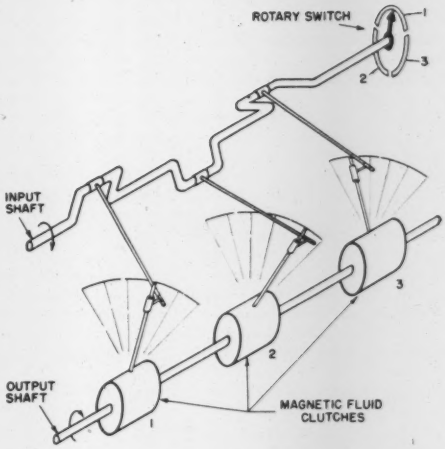

FIG. 8 AN OSCILLATING VARIABLE-SPEED TRANSMISSION IN WHICH ROTATION IS FIRST CONVERTED TO AN OSCILLATORY MOTION AND THEN TRANSFORMED, BY MEANS OF CLUTCHES, BACK TO ROTARY MOTION

(Use of the NBS magnetic fluid clutch in this mechanism has been suggested for smoother and more efficient operation. By means of the rotary switch the proper magnetic fluid clutch can be energized.)

particles in these clutches may be equal to or greater than those developed by magnetic attraction.

In most of the clutches now being built the driving and driven parts are two coaxial cylinders. These clutches avoid difficulties due to centrifugal force by using only enough iron powder to fill or not quite fill the working gap between the cylinders. Additional space can be filled with oil, or not, as desired. Then at moderately high speeds the centrifugal forces on the particles are overcome by the magnetic force. This keeps the particles in the gap for operation of the clutch.

When still higher speeds are required, however, the simple cylindrical clutch is not entirely satisfactory since the magnetic forces are not then great enough to balance the centrifugal forces. The Bureau therefore developed a clutch of special design to operate at speeds of 10,000 rpm or more, Fig. 6. If no excess lubricant is used, there is no drag.

ELECTRICAL PROBLEMS

The electromagnetic field for operation of the clutch can be energized by means of an external source of electrical power connected to the clutch by slip rings, or a stationary magnet may be used to transmit the flux to the working members through air gaps. Another possibility is to build a generator into the clutch itself. The magnetic field can be varied either by changing the electromagnetic field of the generator or by moving the permanent magnet toward or away from the poles.

Use of a transformer provides still another method of exciting the clutch.

For many applications it is desirable that the clutch be kept locked most of the time and be released only when current is applied. To do this, a permanent magnet is so arranged that the application of current shunts the flux away from the clutch into a by-pass, thus releasing the clutch without demagnetizing the permanent magnet, Fig. 7.

SPEED OF RESPONSE

It has been found that response time—the time required to

energize and de-energize the clutch—depends entirely on the response rate of the magnetic circuit rather than on the action of the iron particles. The speed of response of the magnetic circuit, in turn, is a function of the inductance of the winding and of the voltage of the source that supplies the current. As in all magnetic devices, laminating the iron structure aids in reducing eddy currents which tend to slow up the rise and decay of magnetic fields.

Invention of the magnetic fluid clutch has suggested a number of possible applications in which the iron particles could be used for purposes other than merely locking two members together. Soon after the development of the clutch, it was suggested that magnetic-particle friction could be used for the transmission of power between cylinders, cones, and other structures which are not necessarily coaxial. In such variations of the old cone-and-disk type of variable-speed friction device, the friction between solid surfaces is replaced by friction between solid members and a magnetic powder.

It has also been suggested that magnetic fluid clutches could be substituted for the one-way clutches used in oscillating variable-speed transmissions, Fig. 8.

Radio Astronomy

A 600-IN. "radio telescope" has been installed by the U. S. Navy at the Naval Research Laboratory Office of Naval Research, where it will be used to study radio "signals" from the sun, moon, and stars; or galactic radiations.

The new telescope is the latest advance in a program of radio astronomy, begun at the laboratory in 1946, to extend the range of astronomical observations.

Although energy is being continually emitted from the sun, moon, and stars, the earth's atmosphere is "opaque" to these galactic radiations, except for two "windows." One of these is in the visual range of the spectrum—those wave lengths to which the eye is sensitive. The other is in the short wave length or microwave radio range, or the band from several millimeters to 30 meters, corresponding to radio frequencies between about 50,000 megacycles to 10 megacycles.

Classical astronomy, using the telescope, is limited in its study of radiations from outer space to those in the first window—the visible portion of the electromagnetic spectrum. But the visible portion of the spectrum is only a very small section of the complete spectrum, ranging from about 0.00003 to 0.001 cm.

Radio astronomy opens the second window. Just as a telescope uses a concave optical mirror, the radio telescope makes use of a large concave metal reflector and a radio-receiving antenna. The reflector has to be larger because radio wave lengths are longer than those of visible light. Just as an astronomer uses an eyepiece, the radio astronomer "looks" at or detects the radiations with an extremely sensitive radio receiver. The radiations obtained in this way may be recorded on a moving strip of paper.

However, the longer wave lengths of radio astronomy make it difficult to obtain the resolution—or ability to distinguish between two sources of radiation in nearly the same direction—that can be obtained with the telescope.

At the Naval Research Laboratory this problem has been attacked by using larger-diameter reflectors and shorter radio wave lengths. The 50-ft-diam high-resolution paraboloidal reflector that has been installed at the laboratory will initially make use of three wave lengths—3, 10, and 30 cm. Although solar radiations have been detected at these wave lengths, galactic radiation, to date, has not been detected at wave lengths shorter than 60 cm.

It is hoped that with the high sensitivity and directivity obtained with the 50-ft dish, radiation will be detectable at 1000 megacycles (corresponding to a wave length of 30 cm). It is also expected that those same qualities will permit observers to distinguish between areas on the sun, and thus, for example, to study sun spots and hydrogen "flares."

The reflector is mounted on one of the Navy's 5-in. gun mounts. It is arranged to rotate a full circle in the horizontal plane or azimuth and also to move vertically, or in altitude, from below the horizon to 5 deg beyond the zenith. An axis converter corrects for the inclination of the earth's axis and permits the reflector automatically to "track" the sun in its path across the sky, which of course changes from day to day.

The radio telescope can be controlled manually, or connected to a 5-in. astronomical telescope by remote control. If desired, the system can also be controlled manually at the reflector mount itself. The reflector consists of 30 aluminum sections which are bolted together to form the solid surface, which was machined to a tolerance of $^1/_{32}$ in. with a special boring mill. See frontispiece on page 282 of this issue.

The equipment is mounted atop one of the laboratory buildings and weighs about 75 tons. The 50-ft dish weighs only about 14 tons, the Navy gun mount itself accounting for about 27 tons of the over-all weight.

Although the reflector is installed, the sections must first be aligned and the curvature accurately determined to establish the focus of the parabola, where the receiving antenna will be placed. The radio-receiving equipment must also be added before the system can be placed in operation. It is expected that this will be accomplished shortly.

The program of radio astronomy at the laboratory seeks first of all to extend man's knowledge of the universe through study of such problems as the composition of the sun's atmosphere; times and nature of radio emissions from the sun, moon and stars; cause and nature of solar outbursts or flares.

Such information is also expected to be of practical application in long-range weather forecasting and in radio communication. Solar flares, for example, are known to interfere with radio communication, but complete knowledge of why this is so is lacking.

Radio astronomy using microwaves is also engaging the attention of scientists at the National Bureau of Standards, and at Cornell University.

Five-Year Labor Agreement

LABOR agreements at the General Motors Corporation were the subject of considerable discussion in 1948 and again in 1950 when G-M broke tradition by signing five-year labor-union agreements. Some of the philosophy and also the answers to probable questions concerning the agreement were outlined by Harry Anderson of the General Motors Corporation, Detroit, Mich., at a Management Division Session during the 1950 ASME Annual Meeting.

According to Mr. Anderson, the corporation had considered employing some form of cost-of-living adjustment in its labor agreements since 1940. The chief bar to such a plan, however, said Mr. Anderson, was that the cost-of-living arrangement alone only kept the worker even with living costs and did not give him the opportunity to share in the advancing technological progress of the country.

Charles Wilson, G-M's president, while confined to a Detroit hospital for several months, conceived the idea of adding the improvement factor increase to the cost-of-living adjustment arrangement.

Under this kind of a plan the worker not only has the purchasing power of an hour of his work protected, he also participates in a fair manner in the constantly improving standard of living of the whole country.

G-M's historic wage-adjustment formula was first employed in a two-year agreement with labor in 1948 and was continued in a five-year nonreopenable contract signed in 1950.

Mr. Anderson emphasized that G-M did not attempt to design its agreement with the intent that it should become a cents-per-hour pattern for other industries. He pointed out that between 1948 and early 1950 few companies and unions incorporated the cost-of-living and annual improvement features in their collective-bargaining agreements. Likewise, in the first six or seven months of 1950 none of the major companies and but a few small companies signed agreements similar to the G-M agreement.

The development wagewise in the automobile industry during the summer of 1950 was unusual, Mr. Anderson said. It may be attributed to a rapid rise in the cost-of-living stimulated by the Korean situation. The gap between the cost-of-living and wages widened rapidly to the point where pressure was again brought to bear on employers to effect some adjustment. The General Motors agreement focused attention on a solution to existing wage problems. The disparity that developed, he pointed out, could not go on unnoticed regardless of whether there had been a G-M agreement or not.

Mr. Anderson urged American management to use the same methods in meeting their employee-relations problems as they have down through the years in the development of new and better products and services.

We must employ these same talents in solving the critical problems of strikes and stoppages arising from short-term agreements negotiated under pressure, he declared. Whether the ideas General Motors has advanced are the answer is not important. It is important, however, that each company meet its particular employee-relations problem with the same initiative and imagination that it has put to use so successfully in all other phases of its business.

Metal Recovery

STRATEGIC metals from former wastes are helping to meet wartime demand, the February, 1951, issue of the *Industrial Bulletin* of Arthur D. Little, Inc., states.

For example, the Union of South Africa has recently agreed to sell to the United States and Great Britain the entire output of uranium recovered from gold ores. Almost all the gold ores of the region show small percentages of uranium compounds. Four recovery plants are planned, and production is expected to begin in about 2½ years. Both old waste dumps and fresh ores will be treated.

Many of the huge slag dumps that accumulated around steel mills during the last war were combed for the masses of iron that sometimes escaped when the molten slag was run off. One company recovered 150,000 tons of scrap iron in one year from such an operation. Dumps of iron ore, discarded in the days when only the highest-grade ores were shipped, are now being beneficiated by various means to increase the iron content. The Bureau of Mines is carrying on a program, now in the pilot-plant stage, to reclaim manganese from slag. An estimated 300,000 tons of manganese may be recovered annually, with a reduction of almost half our ore imports.

The rise of the flotation processes, where finely crushed ore is treated with chemicals to make the minerals gather in a froth on top of the water, has caused re-examination of many dumps left by less efficient processes. During World War II large accumulations of fluorite "tailings" and waste rock were treated in this fashion, with more than 90 per cent of the fluorite recovered. A somewhat older application of the technique has been used in reclaiming cobalt, tungsten, and chromium from grinding-wheel sludges. Lead, zinc, tin, and gold have also been recovered by flotation.

Slag fuming is also used to recover lead and zinc from waste piles. The desired metal is boiled up or "fumed" from the surface of a furnace load of molten slag. The vapor is then converted to metallic oxides and cooled to a solid or powder for further processing into finished metal. There are three such installations in North America now; the latest is for an 800,000-ton accumulation of residue estimated to contain 26 per cent zinc.

Roasting of ore concentrates containing traces of the desired metal can result in concentrates thousands of times richer than the starting material. The richest source of rhenium is molybdenite ore, which contains from 0.6 to 0.7 per cent molybdenum and only 0.0001 to 0.05 per cent rhenium. The flue dusts from roasting contain up to several per cent of rhenium, and are the present source of supply. Rhenium is similar to tungsten and may be substituted for it in many applications.

Germanium is similarly obtained, mainly as a by-product from smelters handling zinc ores containing traces of the element. It is expected that flue dusts and ashes resulting from the burning of coal containing germanium will in time become the most important source. Germanium is used increasingly in the electronics industry.

Flue dust was an important source of cadmium during the last war, but these reserves have now been exhausted, and cadmium is now obtained primarily as a by-product from the refining of cadmium-bearing zinc or lead ores. For many years a minor source of vanadium has been flue deposits obtained from burning oils, such as those from Venezuela, containing traces of the metal. Boiler scale from ships burning Venezuelan crudes also contains usable amounts of the metal, which is sometimes recovered.

Atomic Energy Report

THE Ninth Semiannual Report of the Atomic Energy Commission issued in January, 1951, points out that the AEC has been occupied with two principal activities during 1950. It has carried out the operation of all existing production and development facilities at full capacity. It has placed considerable emphasis on the completion of plans for new plant construction and expanded operations in order adequately to serve the nation's interests in the years immediately ahead.

This program, probably more than any other in the United States Government today, is carried on through contracts with private industry rather than by direct Government operation, the report states. The enlistment of a large and growing cross section of industry in the provision of business methods and scientific and engineering competence is one of the AEC's aims.

The report is made in two parts. Part 1 reports what can be described in an unclassified document about progress and activities in major programs of the AEC during 1950. The Joint Committee on Atomic Energy of the Congress is kept currently informed of progress and activities through classified reports and other communications and through consultations and hearings.

Part 2 describes administration of the atomic-energy contracts—how programs are planned, contracts are administered, and controls established and executed to assure performance and to carry out the policies and purposes of the Atomic Energy Act of 1946.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Steam Power Generation

Improving Ship Propulsion Gears by Shaving, by H. W. Semar, Westinghouse Electric Corporation, Philadelphia, Pa. 1950 ASME Annual Meeting paper No. **50—A-146** (mimeographed).

IN 1942, at the instigation of the U. S. Navy, a number of shaving machines up to 96 in. in diam capacity were applied to the production of gear units for the propulsion of naval vessels. Since that time the development of the process has continued and its use has broadened to include shaving of gears of the largest sizes used in merchant and naval ship propulsion.

Briefly, the shaving method is a cutting process, using a cutting tool and machine as do the standard hobbing and shaping machines. The tools themselves, hobs, shaping cutters, and shaving cutters, have a basic similarity in that their cutting edges are elements of single or multitoothed gears. Geometrically, they are similar, differing only in the number of teeth and the number of cutting edges per tooth. They are all basic involutes in themselves and they generate involutes by virtue of their rotation in relation to the rotation of the gear.

Shaving will make a good gear better; it will not make a good gear out of a poor one. The final shaved gear, in so far as certain fundamental elements are concerned, will be improved to establish a high quality level. In other respects, the quality level must be established by the preshaving process.

The application of shaving to larger-size gears introduced several new problems. In smaller shaving machines, the work can be conveniently mounted on centers. With larger and heavier parts, however, it is necessary to support the gear on its own journals. This not only provides maximum rigidity, but insures that the rotation of the blank is true with respect to its journals.

Since the shaving cutter must be held in precise relation to the gear axis, the running clearance of an ordinary journal bearing would be undesirable. A steady-rest type of support was suggested, which would give a rigid two-point support to the journal, and in addition, to give full protection to the finished journal from damage caused by chips and dirt.

In shaving smaller gears, it is the practice to establish the final tooth thickness by the shaving operation; that is, the preshaving process allows material for shaving, but this amount need not be accurately controlled. The shaving operation simply continues until the final tooth thickness is established.

With larger gears, however, the best results have been obtained by shaving a minimum of material from the tooth faces. Consequently the shaving operation continues just long enough to clean up the tooth faces to establish a continuous shaved surface. Generally, 0.001 to 0.002-in. reduction in tooth thickness is sufficient. The process therefore requires careful attention and inspection by the operator after each pass.

Stress and Deflection Tests of Steam-Turbine Diaphragm, by V. C. Taylor, Newport News Shipbuilding and Dry Dock Company, Newport News, Va. 1950 ASME Annual Meeting paper No. **50—A-49** (mimeographed; to be published in Trans. ASME).

THIS paper gives the results of tests made on a high-pressure and a low-pressure steam-turbine diaphragm. These diaphragms were subjected to loads which were applied uniformly along a semicircular arc. Data were taken on the deflection, reaction distribution, and nozzle vane stresses. The information derived from these tests is incorporated in a method for calculating diaphragm stresses and deflections.

The solution for the stresses and deflections in a turbine diaphragm is complicated by the fact that it is a split ring rather than a continuous ring. It is, however, necessary to split the diaphragm into halves in order to facilitate the assembling of the turbine. The combination of the split diaphragm and the nozzle vane make a complex structure.

Four important factors that must be considered in the mechanical design of a steam-turbine diaphragm are: (1) The deflection of the diaphragm due to steam loading, (2) the distribution of the reaction, (3) the stress in the nozzle vanes, and (4) inner and outer ring stresses.

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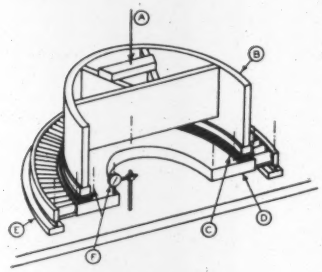


A APPLIED LOAD
B LOADING FRAME
C RUBBER
D DIAPHRAGM
E SUPPORTING RING
F DIAL INDICATORS FOR MEASURING DEFLECTION

ARRANGEMENT FOR TESTING LOW-PRESSURE DIAPHRAGM

Because of the complexity of the structure, any mathematical solution must be based on a simplification of the problem. The tests indicate that in most cases the deflection will be the limiting factor in diaphragm design. Wahl's method gives deflections which are reasonably close for diaphragms with short vanes, but are too low for diaphragms with longer vanes.

The reaction distribution curve should be known or estimated before vane stresses can be calculated. This can be done by using Wahl's method and distributing the negative reaction over the adjacent diagram.

It is suggested that stresses in the diaphragm rings be calculated by taking a section through the center and calculating the difference (algebraic sum) between the moments produced by the steam loading and the reactions.

Intake-Tunnel Design for Condenser Circulating Pumps, by A. I. Ponomareff, Westinghouse Electric Corporation, Philadelphia, Pa. 1950 ASME Annual Meeting paper No. **50—A-138** (mimeographed).

FOR many years low-speed horizontal-centrifugal pumps were used for condenser circulating-water service. Being suitable for suction-lift operation, these pumps are usually located some 10 to 15 ft above the intake-tunnel water level. The long suction pipe and suitably designed suction chamber in the pump casing effectively eliminate turbulence that might be present in the tunnel and produce uniform velocities at the entrance to the pump runner. While some operating difficulties due to unsatisfactory intake-tunnel arrangement were reported, they were few in number and did not require extensive tunnel modifications for correction of erratic operation of the pump.

The present trend toward more compact design of steam-power generating stations has resulted in a severe limitation of space for condensing-plant installation. Space limitations and requirements for flood protection have influenced to a great extent the choice of the type and shaft arrangement of the circulating pumps. Most power-plant designers now select higher-speed vertical circulating pumps of the mixed-flow and propeller types. The increased use of high-speed vertical pumps accentuated the importance of intake-tunnel design. These pumps are designed for relatively high velocities and require uniform flow in the tunnel for satisfactory operation.

The paper gives the basic requirements for the design of intake tunnels for high-specific-speed vertical pumps. Structural limitations and other considerations, however, at times prohibit the use of the ideal location and arrangement of the suction tunnel. The use of small scale models of pumps and intake tunnels permit the observation of flow patterns and evaluation of the hydraulic characteristics of the tunnels and their influence on pump performance. Corrective measures, developed through the use of models, are successfully applied to the prototype to eliminate unsatisfactory tunnel characteristics.

Results indicate that vertical propeller and mixed-flow pumps, particularly in large sizes, are ideal for surface-condenser application. Their steep head-capacity curve is most suitable for parallel operation and frequently eliminates the necessity for priming apparatus. Satisfactory performance of these pumps, however, is dependent on uniform flow to the suction which makes the proper design of intake tunnels mandatory. The design of intake tunnel is so closely related to pump performance that cooperation between the pump manufacturer and those responsible for intake-tunnel design is essential.

Lubrication

Viscosity and Density of Lubricating Oils From 0 to 150,000 Psig and 32 to 425 F, by Donald Bradbury, Rhode Island State College, Kingston, R. I., Melvin Mark, General Electric Company, West Lynn, Mass., and R. V. Kleinschmidt, Harvard University, Cambridge, Mass. 1950 ASME Annual Meeting paper No. **50—A-72** (mimeographed; to be published in Trans. ASME).

DURING the past two years the ASME Research Committee on Lubrication has sponsored work at Harvard University to obtain data over as wide a range of pressure and temperature as practicable, on the viscosity of a carefully selected group of lubricants. The primary object was to obtain data which would permit correlation of the pressure-viscosity coefficient with the results of friction and wear tests on actual machines. It was also desired to provide data which would permit correlations of pressure-viscosity coefficient with other properties such as the temperature-viscosity coefficient and possibly the compressibility. The original program involving some 42 specimens, is nearing completion, and a complete report will be published by the Committee as soon as practicable. This paper contains a brief description of the apparatus and methods employed, a few typical data to show the type of information which will be available, and a few correlations that have already appeared as a result of the work.

A study of the empirical equations presented to date indicates that all had inherent limitations that would prevent extension to cover the data at the extended pressure and temperature range now available. Even the equations presented in this paper are limited in range, although not enough information is yet available to make a complete study of the limitations. The indications are that the equations are good for petroleum oils within the range tested, but may not be very accurate for the lower pressures at temperatures much above 425 F. Tests on a synthetic lubricant of applicability is somewhat narrower than for petroleum oils.

Textiles

New Developments in the Italian Rayon Industry, by F. Perutz, Snia Viscosa, New York, N. Y. 1950 ASME Annual Meeting paper No. **50—A-145** (mimeographed).

ITALIAN production of high-grade rayon cellulose from a domestic cane, *Arundo donax*, now totals 44,000 tons a year and is helping the Italian synthetic-fiber industry meet its difficult problem of acquiring raw materials.

Snia Viscosa, an Italian firm, produces 90 per cent of that country's viscose rayon. Previously, rayon cellulose was obtained from northern fir and spruce grown in Norway, Sweden, Finland, and Canada.

It was found that the cane *Arundo donax*, whose stalks were used as stakes in vineyards in Italy, was fully satis-

factory for the production of high-grade cellulose. This is a perennial plant with an annual production cycle and reproduces by the planting of shoots. This cane is capable of providing an annual output in wood many times greater than any conifers.

From a small initial production, this combined agricultural and industrial enterprise has been developed to its present state.

Two other developments in the Italian rayon industry are reported.

For some years the carpet industry has been looking for artificial fibers that would give the same hand, soil resistance, durability, and springiness which can be obtained from natural fibers. The synthetic material has given this industry a more staple product, both in so far as quality and price structure is concerned and which, in extensive tests, has proved to be equal in all other respects to carpet wool.

The company has been successful in producing a fiber which has not been surpassed by any similar product in the world, and which is marketed under the trade name Novatex. The fiber is a blend of 10 and 18 denier and is usually used in lengths of 3 to $5^1/_2$ in. Its special finish gives this fiber the crispness and smooth surface necessary for high soil resistance.

Another development is the spinning of high-count combed yarns made of viscose rayon. These fine yarns have been used in many fabrics in Italy where they replace combed yarns made out of Egyptian cotton. They are at present used by one of the most prominent manufacturers of men's suitings in this country, a fabric which has been widely advertised.

Properties of Metals

The Creep and Stress-Rupture Testing of Steam-Boiler Materials, by J. B. Romer and H. D. Newell, The Babcock & Wilcox Tube Company, Beaver Falls, Pa. 1950 ASME Annual Meeting paper No. **50—A-129** (mimeographed).

PRESENT-DAY high efficiency and reliability of boilers is due largely to studies made during the past 25 years on the properties and behavior of metals under long-time exposure to stress at elevated temperatures.

Today, large boiler units may range in capacity up to 1,380,000 lb of steam per hr. Superheat temperatures are crowding 1100 F at the turbine throttle with design pressure as high as 2600 psi. Process steam is produced at the even higher temperatures of 1300 to 1500 F, but at lower pressures than in boilers for power generation.

Investigations of creep and stress-rupture have led to the development of superior construction materials for the superheater and its headers and to improvements in those other parts which operate at lower temperatures, such as drums, steam and waterwall tubes, economizer tubes, and piping.

For steam boilers the main concern is to select suitable materials which will provide sufficient long-time strength, as well as surface and internal stability of metal, to avoid failure or rupture with consequent outage of equipment and economic loss.

Most of the creep tests conducted by B & W have been to determine steady-state creep under constant load and temperature, using solid tensile-type specimens. Where high precision was desired, specimens were of 10-in. gage lengths, while others for the higher temperatures, where uniformity of temperature and control is more difficult, were of 2 or 3-in. length.

Metallurgical examinations of the creep specimens are made after creep testing. This procedure includes hardness and microscopic examination for surface condition and structural or phase changes in the metal as compared with the original untested material. Where sufficient gage length permits the necessary subsize specimens to be obtained, the mechanical properties and impact strength are determined and compared with the metal in its initial condition. The relative stability of various materials under stress and temperature have been thus ascertained for many prominent ferrous materials used in steam-boiler work. Stress has an accelerating action in inducing structural changes. This is quite pronounced in carbon steels with lesser effects in the more stable alloy steels. Oxidation rates may be sharply increased under stress concentration. This is a matter of considerable concern in dissimilar weld construction.

Present practice in B & W's creep laboratory is to run both creep and stress-rupture tests on a material to 10,000 hr or longer at temperatures throughout its use range. Since boiler superheaters are generally expected to last more than 100,000 hr, this test period of at least 10 per cent of the service life is preferred. Long-time tests will usually indicate the beginning of the third creep stage which ultimately leads to rupture.

Stress-rupture tests are conducted to estimate the stress required for fracturing the metal under prolonged loading. They are made by loading the specimens with stresses which will cause rupture of the specimens in time periods ranging from 100 to 10,000 hr, or more. Longer-time rupture tests than 1000 hr are preferred in boiler work and over a range of stresses extending downward to those tending to bridge the gap between the creep test and the rupture tests.

Metals vary in high-temperature, strength, and ductility under stress to a great extent as influenced by a number of factors. Composition, manufacturing history, deoxidation, grain size, and structural condition all impose their effects. At a fast rate a metal may extend appreciably, whereas with slow rates and longer fracture times, it may suffer intergranular fracture with little or no apparent deformation. The stiffer and more creep-resistant the metal is the more is this characteristic in evidence.

Heat Transfer

Heat and Momentum Transfer Through Steam in Plain and Modified Annuli, by George W. Govier, University of Alberta, Edmonton, Alberta, and Robert R. White, University of Michigan, Ann Arbor, Mich. 1950 ASME Annual Meeting paper No. **50—A-81** (mimeographed).

HEAT-TRANSFER coefficients and friction factors are determined for superheated steam flowing in annuli formed between a 4.026-in-ID shell and a 1.500-in-OD tube, and three 1.500-in-OD tubes supporting extended surfaces of various types. The transfer section is 15 ft long for the finned tubes. The Reynolds number of the steam is varied from 5000 to 102,000 over the temperature range of 294 F to 460 F at two pressures of 50 and 100 psi abs. Temperature differences between the heated inner tube and the steam vary from 30 F to 160 F.

The gas phase heat-transfer coefficients, based upon the total exposed surface, are found to range from 2.85 to 26.2. From 6.6 to 59 per cent of the total heat transfer is accomplished by radiation. The convection heat-transfer coefficients are correlated by Dittus-Boelter type equations using an equivalent diameter defined as the ratio of the free volume for flow to the total wetted surface. The pressure-drop data are correlated by relating the friction factor to a modified Reynolds number. These data are used to indicate the relative performance characteristics of the various types of extended surface.

Heat Transfer to a Fluid Flowing Turbulently in a Smooth Pipe With Walls at Constant Temperature, by R. A. Seban and T. T. Shimazaki, University of California, Berkeley, Calif. 1950 ASME Annual Meeting paper No. **50—A-128** (mimeographed; to be published in Trans. ASME).

THE case of heat transfer to an incompressible fluid of constant properties flowing turbulently within a pipe having constant wall temperature has been investigated analytically. Heat-transfer coefficients were obtained by R. C. Martinelli for the same flow conditions in a pipe having a linear variation of wall temperature obtained from a constant heat-transfer rate along the pipe length. At low Prandtl numbers, such as obtained with molten metals, the ratio between the coefficients for these two cases may become as low as 0.73, with the coefficient for the constant wall temperature case being the smaller of the two.

The Nusselt numbers obtained for the case considered can be obtained with an accuracy of ±6 per cent from the empirical equation

$$\frac{hD}{k} = 5.0 + 0.025\left(\frac{u_m D}{\alpha}\right)^{0.8}$$

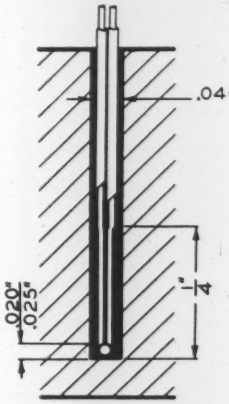
for Prandtl numbers less than 1/10.

The present results are in agreement with experimental data for a Prandtl number of 0.46 but data for lower Prandtl numbers are too meager to allow a discrimination between the constant heat rate and constant wall temperature cases.

A Method of Measuring Local Internal Temperatures in Solids, by H. Dean Baker, Columbia University, New York, N. Y. 1950 ASME Annual Meeting paper No. **50—A-101** (mimeographed).

ACTUAL measurement of local internal temperatures of solid bodies can furnish knowledge of temperature distributions and can also provide means for the estimation of local heat-transfer rates. This knowledge is often important in industrial situations where, for instance, heat-transfer rates may affect the functioning of equipment and unsuitable temperature distributions may jeopardize machinery or unfavorably affect materials in process. Without a method of direct measurement, determinations of temperature distributions and heat-transfer rates are difficult and uncertain.

A widely applicable thermocouple technique therefore has been developed for the measurement of local internal temperatures in solids. This technique has been subjected to laboratory tests,



SAMPLE INSTALLATION FOR THE MEASUREMENT OF LOCAL TEMPERATURE

which are described in the paper, as well as extensive service under industrial operating conditions. By choice of details, the design can be made to a wide range of specifications.

The procedure always requires a small hole, a fine-wire couple, and cement, or other filling between the wires and the parent body.

Execution of such designs of cemented-in thermocouples occurs in the following steps: (1) Locating and producing the hole, (2) preparing the junction, (3) cleaning and filling the hole with cement, and (4) inserting the junction.

The diameter of the hole required by the design may be only slightly larger than the wire. The depth may be anything greater than the required length of immersion. For surface temperatures the hole may be parallel to the surface, or a groove may be used.

Installations may be performed in any material in which a hole of suitable dimensions can be produced. Since a refractory cement is used, operating temperatures can ordinarily be as high as those permissible for the thermocouple materials.

Strain-Hardening and Softening With Time in Reference to Creep and Relaxation in Metals, by A. Nadai, Pittsburgh, Pa. 1950 ASME Annual Meeting paper No. **50—A-121** (mimeographed).

ANALYTICAL expressions are formulated for describing the influence of strain-hardening, of the time rate of change of the flow resistance, and of recovery strains on the creep and relaxation of metals under uniaxial stress.

The problems of the slow deformation or creep of metals under stress at high temperatures raise many questions of a metallurgical, a physical, and a mechanical nature. Leaving aside a discussion of the involved phenomena occurring in the lattice structure of the polycrystalline metals causing creep and fracture in metals after long exposure to stress at elevated temperatures, the interest of engineers has not subsided in a mechanical interpretation and treatment of these questions. Such a treatment is still required to correlate the results of the numerous long-time creep tests which have been made during the last 20 to 25 years under varying conditions in industrial laboratories for supplying much-needed information to machine designers.

The mechanical theory of creep is concerned with the relations between stress, and elastic and permanent parts of the strains, the rates of the permanent strains, and the time at given temperatures.

In this paper cases of flow under uniaxial stress are considered only with a view toward improving the correlation between tensile tests of various types.

Relaxation of Stress in a Heat-Exchanger Tube of Ideal Material, by E. A. Davis, Westinghouse Electric Corporation, East Pittsburgh, Pa. 1950 ASME Annual Meeting paper No. **50—A-122** (mimeographed).

RELAXATION is the redistribution and decay of the stress in a body in which a constant total strain is maintained. Under such circumstances any increase in plastic strain must be counterbalanced by an equivalent reduction in the elastic strain. Probably the most familiar example of relaxation is the decay of the stress in the bolts of turbine cylinder or steam-piping joints. However, the redistribution and the decay of the shrink-fit stresses in turbine disks and the rolled-in stresses in heat-exchanger tubes are also examples of relaxation. Actually, these examples represent true relaxation problems only if the flanges or the shafts or the tube sheet can be considered as rigid. In most cases the stresses in these parts are much lower than in the parts under consideration and hence the assumption of relaxation conditions is made. In the heat-exchanger tube sheet, for example, the minimum spacing between holes is usually about four times the tube wall thickness. This makes the average hoop stress in the tube at least twice that part of the tube-sheet stress that is

due to the tube rolling. Furthermore, the tube sheet material is usually much stronger than that used in the tubes.

Practically all relaxation tests are carried out on tensile specimens. Therefore very little is known about the effect of a state of combined stress upon the relaxation of materials. The present paper is concerned with the relaxation of a very simple ideal material in which the behavior under combined stress can be determined.

It was determined that for the ideal elasticoviscous material a rolled-in condenser tube will relax at a slower rate than a tensile specimen. For actual materials it would seem that the tube would relax still more slowly. In any event the tensile relaxation data offer a safe guide to the relaxation of the tube. Based on the results of these calculations this same remark cannot be made for the relaxation of a disk on a shaft.

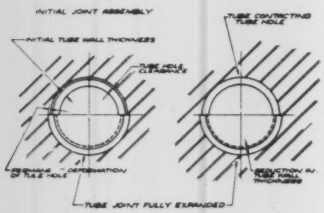
For the type of unloading and reloading in present heat-exchanger tubes, the relaxation is not much affected by reloading.

Expanded Tube Joints in Feedwater Heaters and Heat Exchangers, by F. F. Fisher and G. J. Brown, The Detroit Edison Company, Detroit, Mich. 1950 ASME Annual Meeting paper No. **50—A-124** (mimeographed).

THE making of expanded tube joints in tube sheets of unfired pressure vessels is discussed. Present-day practice of rolling-in such tubes is reviewed and information gained from installing, retubing, testing, and repairing many types of heat exchangers is presented.

It is recommended that the optimum degree of expanding be determined by tests conducted in advance of actual rolling operations and that the information so obtained be recorded and made available to others. Preference is given to the automatic relay-operated technique for uniform tube rolling.

It is proposed that tube joints be shortened to a minimum; and that with thick tube sheets, the unrolled portion of the joint be sealed by lightly rolling a short section of tube, preferably with automatic tube-rolling devices. The same method is preferred when rolling tubes to specific design instructions, because manual rolling-in does not produce specified results with certainty. Nonferrous tubes rolled into steel tube sheets with a joint length of $2^1/_2$ in. have proved satisfactory. Tube-hole clearance should be kept to a minimum. The drilling of smaller than conventional holes in the support plates of heaters and condensers provides an effective means for elimination or reduction of tube vibration and consequent tube wear.



THREE STAGES OF TUBE ROLLING

As to finish, it was pointed out that rolled joints are primarily friction joints and that their holding strength depends upon the pressure and roughness between the contacting surfaces. On the other hand, pressure tightness is best obtained by use of smooth contact surfaces. For example, relatively rough tube holes can be used in heat-exchanger work if the tubes are much softer than the tube sheet. But if the tube material is hard, greater movement is produced between the contacting surfaces, and the axial flow of tube metal may shear or smooth off any roughness of the tube hole. For this reason the tube holes in boiler construction are reamed cylindrical and smooth and the reinforcing grooves are placed near the zone of minimum movement of the tube metal.

In order to bring out the full strength of a joint without undue distortion or damage to the tube sheets and headers, the tube metal should be softer than that of the tube sheets or headers.

Particular attention should be paid to the sequence of rolling-in tubes in order to reduce to a minimum, or to eliminate entirely, stresses caused by the elongation incident to tube expanding.

Notes on a Theoretical Basis for the Design of Tube Sheets of Triangular Layout, by I. Malkin, Foster Wheeler Corporation, New York, N. Y. 1950 ASME Annual Meeting paper No. **50—A-120** (mimeographed).

THERE are a variety of heat exchangers which function by means of a great number of tubes, enclosed in a shell or in a casing, and properly fixed in tube sheets. A tube sheet is a plane plate of constant thickness with circular holes for connection with the tubes.

An approximate analytical procedure for determination of the elastic surface of tube sheets under bending is presented. The procedure derived has been used successfully for several years as a basis for design of tube sheets of the frequently applied triangular pitch. The design formulas developed in the paper underwent experimental tests with practically satisfactory results. A description and detailed discussion of the experimental work is also given in this paper.

A circular tube sheet on three-point supports 120 deg apart has three advantages, namely, the problem has an exact solution; the boundary conditions can be realized easily and accurately (statistically determined problem); the solution is known both for the uniformly distributed and centrally applied concentrated load.

Gas Turbine Power

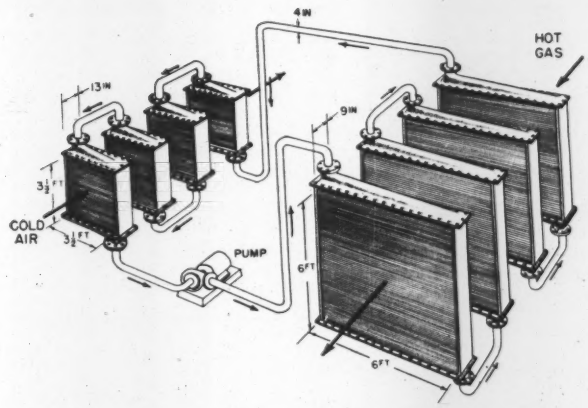
The Liquid-Coupled Indirect-Transfer Regenerator for Gas-Turbine Plants, by A. L. London, Mem. ASME, and W. M. Kays, Jun. ASME, Stanford University, Stanford, Calif. 1950 ASME Annual Meeting paper No. **50—A-89** (mimeographed; to be published in Trans. ASME).

THE advantages of a liquid-coupled indirect-transfer-type gas-turbine plant regenerator relative to the conventional direct-transfer-type are given. The indirect system consists of two units, one a hot gas-to-coupling liquid exchanger, and the other a coupling-liquid-to-compressed-air heater, together with the necessary circulation system for the coupling liquid. One of the liquid-metal alloys possessing a high heat-transfer coefficient, a low freezing point, and a high boiling point might prove to be suitable as a coupling liquid. As an example, the sodium-potassium eutectic alloy might be practical.

Design studies are presented to give an idea of the geometry of indirect-type regenerators for four different gas-turbine cycles. One of these cycles may be considered as typical of a conventional, open-cycle central station or marine plant, the second is like the first only it is a closed supercharged cycle, the third is a locomotive plant, and the fourth is an aircraft turboprop system.

The development of the indirect-type liquid-coupled regenerators, it is pointed out, hinges on the availability of a good coupling fluid.

Granting that such coupling liquids will be developed, the indirect-type re-



EXPLODED VIEW OF AN INDIRECT-TYPE GAS-TURBINE REGENERATOR FOR A 5000-SHP PLANT

generator possesses substantial geometrical advantages over the direct type. Significant simplifications of the machinery arrangement and gas and air ducting are possible, which are particularly advantageous in the gas-turbine locomotive and aircraft turboprop applications.

The pumping power required to circulate the coupling liquid is small and the piping sizes are moderate. Likewise, the increase in total heat-transfer area for the indirect versus direct-type regenerator is relatively minor.

Fabrication costs for liquid-to-gas transfer surfaces with fins on the gas side, as used in the indirect-type, may prove to be substantially smaller than for gas-to-gas surfaces requiring fins on both sides, as in the direct-type regenerator.

The theory of coupled exchanger systems presented in this paper may prove to be of use in a number of applications other than the gas-turbine regenerator as specifically considered here.

Review of Combustion Phenomena for the Gas Turbine, by D. G. Shepherd, Jun. ASME, Cornell University, Ithaca, N. Y. 1950 ASME Annual Meeting paper No. **50—A-96** (mimeographed; to be published in Trans. ASME.)

DESIGN data for combustion in gas turbines is negligible when compared with that available for the other major components—the compressor, turbine, and heat exchanger. These components, if conservatively designed, can be relied upon to give a performance close to that expected, whereas even a conventional combustion chamber requires extensive development and testing under both simulated and operating conditions. Although combustion is a separate self-contained process with no other functions to consider, the stringent requirements with respect to space, weight, and power loss, together with the complex chemical, physical, and aerodynamic phenomena involved, combine to render it a formidable problem. Such data as exist at the present time may be divided into three groups:

1 Very meager statistical data from existing gas turbines, such as combustion intensity and fractional pressure loss.

2 Information on combustion behavior in analogous circumstances, e.g., in oil and gas furnaces, spark and compression-ignition engines.

3 Empirical data on general combustion phenomena, which of recent years is being reconsidered in the light of reaching an understanding of the basic mechanism of combustion by fundamental studies of the physical chemistry of ignition, flame propagation, and burning.

It is this last group which holds the most promise for the gas-turbine engineer. At the present time it presents a rather unwieldly mass of material which, although being expanded rapidly, is only beginning to shed light on the complex problem of burning a mixture of hydrocarbons in a turbulent high-velocity stream of air. The combustion engineer is confronted with a large body of scattered information which often appears to be remote from the practical design of a combustor, and it is the purpose of this paper to attempt a brief survey of some of this fundamental investigation and to correlate it with existing combustion-chamber performance.

ASME Transactions for March, 1951

THE March, 1951, issue of the Transactions of the ASME, which is the *Journal of Applied Mechanics* (available at $1 per copy to ASME members, $1.50 to nonmembers) contains the following:

TECHNICAL PAPERS

An Iterative Numerical Method for Nonlinear Vibrations, by J. E. Brock. (50—APM-1)

Thermal Effects in Calendering Viscous Fluids, by M. Finston. (50—SA-13)

Stress Concentrations Around Spheroidal Inclusions and Cavities, by R. H. Edwards. (50—APM-20)

Influence of Rotatory Inertia and Shear on Flexural Motions of Isotropic, Elastic Plates, by R. D. Mindlin. (50—APM-22)

Fluid Flow Through Porous Metals, by Leon Green, Jr., and Pol Duwez. (50—SA-17)

A Method of Numerical Analysis of Plastic Flow in Plane Strain and Its Application to the Compression of a Ductile Material Between Rough Plates, by R. Hill, E. H. Lee, and S. J. Tupper. (50—APM-17)

Emissivity Calculations for Diatomic Gases, by S. S. Penner.

The Solution of Elastic Plate Problems by Electrical Analogies, by R. H. MacNeal. (50—SA-23)

The Dynamics of the Buckling of Elastic Columns, by N. J. Hoff. (50—APM-23)

Evaluation of Stress Distribution in the Symmetrical Neck of Flat Tensile Bars, by Julius Aronofsky. (50—A-14)

Shakedown in Continuous Media, by P. S. Symonds. (50—A-17)

Solution to the Rolling Problem for a Strain-Hardening Material by the Method of Discontinuities, by Alice Winzer. (50—APM-19)

A Superposition Analysis of the Turbulent Boundary Layer in an Adverse Pressure Gradient, by D. Ross and J. M. Robertson.

Pressure Distribution in the Calendering of Plastic Materials, by J. T. Bergen and G. W. Scott, Jr. (50—A-34)

DESIGN DATA

Factors of Stress Concentration for Slotted Bars in Tension and Bending, by M. M. Frocht and M. M. Leven

DISCUSSION

On Previously Published Papers by Holt Ashley and George Haviland; R. L. Bisplinghoff, T. H. H. Pian, and L. I. Levy; E. Creutz; H. I. Flomenhoft; D. F. Gunder and D. R. Friant; J. H. Keenan, E. P. Neumann, and F. Lustwerk; P. S. Symonds and W. Prager; W. T. Thomson; L. F. Coffin, Jr.; and H. J. Reissner and G. J. Wennagel.

BOOK REVIEWS

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Gas Turbines in Naval Applications[1]

COMMENT BY P. D. GOLD, JR.[2]

The remarkable progress of the gas turbine during the past few years after its near-dormant state since its early conception is due to the great strides our research engineers have made in perfecting the components, permitting increased temperatures and pressures, and increasing the efficiency of these components. This progress has now brought the gas turbine to that state of efficiency which permits its use in those applications where weight and space are at a premium.

The authors' résumé of the history of the gas turbine and the Bureau of Ships' development efforts prove that this prime mover has been given much earlier recognition than have new types in the past. The reciprocating steam plant was made commercially available in 1712, due to the efforts of Newcomen. Despite the obvious superiority of steam over sail, it was not until 1793 that Robert Fulton produced the first steam vessel. Again, in 1884, Parsons and De Laval introduced the steam turbine; however, its first naval application was not until 1897. The Diesel engine, available in 1892, was not adopted by the marine engineer until 1910. The first commercially available gas turbine appeared in Switzerland in 1938, and, in 1947, was successfully propelling a British naval vessel. Today ten gas-turbine propulsion plants are in the process of manufacture or test for marine use.

The reason for the relatively rapid acceptance of the gas turbine by the normally conservative marine engineer is the versatility of form of which it is capable without abandoning relatively good fuel economy. In aircraft use it is, above all else, the lightest prime mover per unit of propulsive thrust available, and its mechanical simplicity has enabled it to meet rigorous aircraft standards of reliability at the same time. In electric power-generating stations, its economy and reliability are paramount—in this field, it has approached the Diesel in specific fuel consumption. Between these two extremes, that is, the simple cycle with minimum specific weight for short life at high temperature on the one hand and complex cycle with minimum fuel consumption and long life at moderate temperature on the other, there lies an almost infinite choice of cycles and arrangements capable of showing, in any one arrangement, superiority in at least the one characteristic which is paramount for the application at hand.

The writer would like to express appreciation to the authors for their interesting report to the technical public of the gas-turbine activities of the Bureau of Ships, and for the stimulating suggestion which they have placed before us. It is believed that the gas-turbine installation such as the authors propose using for their combined plant could be put on full load in about 30 seconds after starting from cold. If this is true, then this feature merits emphasis in the application proposed by the authors. When lying at anchor or cruising in a location susceptible to aircraft or submarine attack, instant readiness of full power must be assured in the naval plant. The gas-turbine arrangement proposed would result in a worthwhile fuel saving by eliminating the high fuel costs in maintaining the steam plant in a "stand-by" condition.

One characteristic required by the naval power plant and of less importance to other applications is low noise level. It is suggested that the authors comment on the relative noise level between this and other prime movers, and on the present efforts toward noise suppression.

The engineering highway is so broad that it is difficult to stay in the middle of the road. It is difficult to be both enthusiastic and conservative. Both, however, are necessary, and it is the writer's belief that the authors have indicated that they are guilty of neither overenthusiasm nor ultraconservatism. We must agree with them that the gas turbine is now available as a very useful tool for the naval design engineer for special application.

COMMENT BY R. M. HAZEN[3]

The foresight and perseverance of the Navy in pursuing the development of the gas turbine for aircraft has contributed materially to the present dominant position of this type power plant in aircraft propulsion. In other power-plant fields the gas turbine still finds itself facing stiff competition from Diesel and steam prime movers and also perhaps the natural distrust of "new fangled" power plants. This excellent paper fulfills a definite need in showing the extended possibilities of the gas turbine when its special characteristics are recognized and properly exploited.

The scheme of operating several smaller units in parallel for a given power requirement offers many advantages. By cutting out a suitable number of units with decreased load, the problem of part-load economy is effectively solved. The advantages from standpoint of reliability and battle damage are obvious. Where the bulk of operation is at one-quarter to one-third maximum power, as in the destroyer example cited, the over-all installation life can be increased substantially by the obvious expedient of alternating load between units. The specific power-plant weight, in general, increases for the very large sizes so that the installed weight of the multiunit arrangement might not be very different from a single large unit. The size effect on component efficiencies is not likely to be significant beyond sizes of 5000–6000 hp. The feasibility of clutching arrangements and rapid starting of one unit from another has already been demonstrated on aircraft-type turbines.

The writer concurs that blade cooling must be considered in any long-range development program for the gas turbine. Air-cooling presents considerably fewer problems than liquid-cooling, and shows promise of permitting 500–600 F increases in turbine-inlet temperature. It should not be overlooked, therefore, even for marine applications. In order to take advantage of the near maximum

[1] "Prospects of Gas Turbines in Naval Applications," by R. T. Simpson and W. T. Sawyer, MECHANICAL ENGINEERING, vol. 72, September, 1950, pp. 712–716.

[2] Captain, USN, Bureau of Ships, U. S. Navy Department, Washington, D. C.

[3] Director of Engineering, Allison Division, General Motors Corporation, Detroit, Mich.

temperatures which may be possible with liquid-cooling, considerable concurrent development of other components such as combustion chambers and high-pressure compressors will be necessary. A casual survey of the problems encountered in keeping clean the various liquid heat exchangers in naval and industrial service will verify that liquid systems can become fouled unbelievably. Whereas the fouling of surfaces exposed to low temperatures merely reduces effectiveness, the local fouling of metal surfaces subjected to the high temperatures encountered in gas turbines would easily cause destructive overheating. The liquid passages in some parts of a gas turbine would defy convenient cleaning. It is altogether probable that the ultimate design may use both air and liquid-cooling as found advantageous for various parts.

With regard to the reasons given by the authors for retaining the steam power plant as the base-load unit of their composite propulsion system, one other potential advantage might be cited.

During periods the gas turbines are operating, the fuel economy of the steam-turbine unit might be improved by using the heat in the gas-turbine exhaust to supplement the boiler, superheater, or feedwater heater of the steam plant. This would, of course, be subject to appraisal of the net weight increase and possible difficulties from fuel residues in the turbine exhaust. However, it appears to this writer that the future potential of the closed-cycle gas turbine is limited because of the serious metallurgical and structural problems associated with the hot-gas heat exchanger. In this respect it seems subject to somewhat the same limitations as that more common "closed cycle" system, i.e., the modern steam turbine. The problem of compressor fouling would better be attacked directly through development of suitable filters or rapid cleaning methods, such as periodic introduction of a cleansing agent at the compressor inlet. The latter technique has shown considerable promise in connection with aircraft turbines.

The authors mention their expectation that much higher pressure ratios will be required in future designs. The theoretical advantages of higher pressures and temperatures must be adjusted to the fact that greater leakages will occur when such conditions exist in this class of rotating machinery. The problems of sealing against such leakages are likely to be among the more difficult ones encountered in the projected developments. This adds emphasis to the thought that a large share of attention should be paid to the regenerative-cycle gas turbine, in which pressure ratios even lower than now used in jet-propulsion turbines are a distinct advantage from the thermal-efficiency standpoint. It also shows less sensitivity to part-load operation. The large gains in thermal efficiency alone that it makes possible should justify continued work on the regenerator component.

COMMENT BY M. L. IRELAND, JR.[4]

The authors' proposal of a naval power plant using conventional geared steam-turbine drive for cruising speeds and gas-turbine booster units to produce maximum power appears to offer great possibilities for reducing the weight and space requirements for high-powered naval propulsion units.

It is assumed that considerable study has been given to obtaining the maximum possible output from the steam-turbine plant in order to reduce the number of gas-turbine units required to develop maximum power. The authors mention 9000 shp per shaft as the maximum output of the steam-turbine plant. The power at the 20-knot cruising speed, where it is desired to obtain maximum economy from the steam-turbine plant, is not stated, and it would be appreciated if the authors could furnish this value.

It would appear that a maximum output of 2.5 to 3 times the economy rating could be obtained without seriously affecting the maximum economy performance.

The following factors will determine the maximum overload capacity:

(*a*) First-stage shell pressure. At the maximum capacity this could be carried up to about 90 per cent of the inlet pressure with a suitable number of stages by-passed.

(*b*) Condenser and exhaust annulus capacity. The over-load capacity of these elements can easily be permitted to triple the economy rating, provided an increase in back pressure is accepted.

For example, if the designed back pressure for the economy rating is 1.5 in., there would be practically no increase at all in exhaust volume flow at the maximum power condition if the back pressure were increased to 4.5 in. The actual performance with no change in circulating-water quantity would correspond more nearly to 3 in. abs pressure, and a 50 per cent increase in exhaust volume flow.

(*c*) Turbine-blade and wheel stresses, critical speeds, etc. The turbine speeds for 150 per cent overload will be about 35 per cent above the economy rating speeds. The extent to which such an overload requirement would increase the weight of the turbines would of course depend upon detail design studies. However, it is believed that the weight increase, as compared to a turbine unit designed for, say, 25 per cent overload, would be small and probably less than that required to obtain the same increase in power through the use of additional gas-turbine booster units.

(*d*) Reduction gears. The design requirements for the reduction gears would probably be based upon the maximum power condition with gas-turbine booster units in use so that the overload rating assigned to the steam turbines is unlikely to affect the reduction-gear design as regards weight and space.

An improvement in the authors' arrangement would result if it should be found possible to provide a steam-turbine unit capable of continuous operation at 15,000 shp per shaft, leaving 15,000 shp to be developed by the gas-turbine booster units at maximum power. Considering current advances in the rating of aircraft gas-turbine units, it would appear entirely practicable to develop this power in two aircraft-type gas-turbine units.

Such an arrangement would simplify the physical and operating complexity inherent in the use of five units as proposed by the authors.

Another factor which should be considered with regard to the multiple booster units proposed by the authors is that, in times of emergency, such units must be immediately available for operation at maximum power. Under such conditions the vessel must carry the necessary maintenance and operating force to insure this instant availability. The use of fewer booster units appears to require a smaller operating force with attendant saving in weight and space requirements for living spaces.

The authors state that they have great confidence in the possibilities of liquid-cooling as a means of increasing the inlet temperature for gas-turbine plants. It would be appreciated if, within the limits of security, the authors could describe briefly the mechanics of the type of liquid-cooling arrangement they have in mind.

It is believed that the ideas proposed by the authors will stimulate further design studies leading to advances in the art.

[4] Engineering Department, Technical Division, Newport News Shipbuilding & Dry Dock Company, Newport News, Va. Mem. ASME.

COMMENT BY R. V. KLEINSCHMIDT[5]

It is a great pleasure to greet former colleagues in the Bureau of Ships, and to compliment them on their excellent and thought-provoking paper. It is also heartening to find that naval officers are still speaking out their convictions, even to the extent of prophecy, in new and unknown fields. The writer is most fortunate in being able to read between the lines many of the things which substantiate their predictions, which security prevents them from disclosing. Although in the main the writer agrees with their conclusions, there are a few places where his own opinions differ from theirs.

The authors state, ". . . the next large-scale project . . . should . . . be composed of elements which are available in fully developed form at present." This was of course the basis of the original wartime projects. The writer is firmly convinced that we must develop the gas-turbine plant as a whole, in an integrated design. To patch it up out of available components would seem to be a waste of time and money under peacetime conditions. The aircraft gas turbine is an example of what can be done with an integrated plant. Of course, the conditions were entirely different from those for a naval plant, but they were no less severe. Again, quoting: "The wealth of literature available on the subject of the selection of the optimum cycle . . ." seems overoptimistic. It is true that there is a considerable number of papers dealing with one cycle or another, but they have never, to the writer's knowledge, been put on a strictly comparable basis, nor have the full potentialities of several possible cycles been explored. The writer is now engaged in an extensive computation project, attempting to show the characteristics of some 30 different types of cycle, over a wide range of every possible variable. This has already shown that high temperature is not the only method of obtaining high efficiency, and there is a serious question whether it is the simplest. Of course, any cycle can be improved by increasing the maximum temperature, but for normal ship propulsion the writer doubts if temperatures above 1800 F will be required for many years. He is particularly hesitant about backing any extensive development of liquid-cooling, although granted that it would be desirable, in view of the problems and complications encountered in the Holzwarth turbine, which depended upon liquid-cooling, and which used a thermodynamically excellent cycle. In stating this belief there is no intention of opposing in any way experimental work on liquid cooling.

The proposed combination steam and gas-turbine plant is interesting. It is suggested, however, that it be compared with a pressure-fired boiler plant which it is believed will give equal or better performance and some simplification of operation. Furthermore it is believed that the free-piston gas generator offers the simplest solution at least for moderate power, and very high-efficiency cruising power plants. The writer also is still convinced that wet compression must be a factor in the ultimate high-efficiency constant-pressure gas-turbine plant.

[5] Harvard University, Cambridge, Mass.; formerly Officer-in-Charge Machinery Development Section, Bureau of Ships, U. S. Navy Department. Mem. ASME.

COMMENT BY W. H. LAW[6]

The authors present a very interesting paper on studies being made by the Navy Department in connection with the adaptation of the gas turbine for propulsion of combatant ships, and, reading between the lines, considerable effort is being made to find a suitable solution.

The writer belongs to that group which believes in more conservative design. Having had considerable experience, particularly on propelling machinery, which extends through two major wars, it would seem that the prime importance in the time of war is continuous performance of the main propelling machinery without breakdown. The paper gives the impression that advantages may be obtained by using main propelling machinery of a more or less expendable type. The writer disagrees with this idea, since procurement of replacements may become very difficult in case of another war, and although perfectly feasible in time of peace may be a very serious matter if machinery of this type were adopted for major combatant vessels.

It should be noted that great progress has been made in the past few years and is being made at the present time in development of main steam propelling machinery which will meet the requirements listed by the authors. It is believed, however, that the idea of weight-saving may be carried too far, thereby sacrificing reliability of operation. The writer would suggest that consideration be given to weight saving in hull structure as well as machinery.

The authors indicate turbine-inlet temperatures of 1900 and 2500 F. It would be interesting to know what safe maximum temperature has been reached on the laboratory sets which have been tested during the past 6 or 8 years for any extended period.

It is believed that the combination of gas turbines and steam turbines has some merit for merchant shipping when size and weight is not of prime importance; however, although this arrangement may appear the ultimate from a theoretical point of view, it is questionable how it would work out from a practical application standpoint on combatant ships.

It is believed, however, that certain advantages may be gained in saving of weight and space by the use of boiler plants with combustion under pressure, and it would appear that a boiler plant of the "Velox" type would offer advantages which should not be overlooked. It is understood that a plant of this type would probably include a gas turbine to operate the compressor. However, it is felt that provision could be made to replace this plant with the conventional steam plant if operating experience would warrant this change without involving replacement of the main propelling machinery. It would be interesting if the authors have any information on developments along these lines. The manufacturer of this type of plant claims that a unit of this type used for stand-by duty on land with a capacity of 10,000 kw was started up from cold condition and paralleled within 7 min, and the full load was attained within 10 min with automatic control and operation, with one man in attendance.

In view of increased attention by the Navy Department to noise level it would be interesting to know how the plant proposed would compare with the conventional steam plant. It is the writer's opinion that the water-borne noises created by the propeller are of much more magnitude than the noises from machinery spaces.

The matter of air inlet and duct work is also of concern to the writer. It would be interesting to know how this matter will be taken care of in the plant proposed by the authors, in so far as it relates to the ship's structure.

It would seem that the development of high-speed submarines as rumored may change the layout of the curve indicated in Fig. 1 of the paper. The authors' ideas on this point would be interesting.

In conclusion it appears that the development of the gas turbine has not progressed far enough to warrant making concrete recommendations of plant layout at the present time. The writer will agree that this may be possible at a

[6] Chief Engineer, New York Shipbuilding Corporation, Camden, N. J.

future time; how near or far is a question. However, it now appears that with the advent of atomic power, developments along this line may bring about a revision of ideas on ship propulsion.

COMMENT BY C. H. MEIGS[7]

In general, the writer agrees with the authors. It would seem that potentially the gas turbine has real promise for a variety of marine applications but that considerable development will be required before any number of gas turbines will be in regular service supplying propulsion power afloat. If it is accepted that this type of prime mover has promise, it follows that the Navy should undertake to advance the development of gas turbines of a type adapted to the unique requirements of naval propulsion. This requires that we concern ourselves equally with the following criteria:

(*a*) Weight of machinery plus fuel for a given cruising radius (which takes account of plant efficiency).
(*b*) Reliability.
(*c*) Simplicity.
(*d*) Construction requirements (which embraces materials and manufacturing facilities required for a large construction program).

Sometimes, from the point of view of the man at the test bed, it seems that during the preliminary design stage and the period which might be termed "selling the idea," the first of the foregoing items (size and efficiency) receives an emphasis out of proportion to the value which will be put upon it by operators who are concerned much more with reliability and simplicity. For this reason it is essential that the protagonist of any new device avoid so emphasizing efficiency as to obtain a machine which, when put into service, will perform in such a manner that the operator will hope that he never sees another. In this connection it is appropriate to point out that, although the substantial improvement in efficiency associated with the extraction (regenerative) cycle is well recognized, very few naval vessels employ this cycle which entails the relatively minor complication of extraction apparatus, high-pressure feed heaters and air heaters—all in common use ashore and in the merchant marine.

It seems that those interested in the gas turbine must be careful to advance along sound lines, slowly consolidating the gains and making sure that whatever is installed afloat gives good promise of not embarrassing them in regard to reliability and simplicity. The steam plant of today is a competitor which will be hard to dislodge. It has promise of further improvement, although now embodying the product of the best thought of hundreds of the foremost mechanical engineers of the last half century. It has many ardent admirers. Boilers, which are by far the heaviest components in a steam plant, can be reduced in weight substantially if pressure-firing and forced circulation are accepted.

Concerning the authors' figures on weight savings associated with the 30,000-shp combined steam-and-gas-turbine plant: It is stated that, in an all-steam plant, the weight of machinery uniquely associated with propulsion is 16 lb per shp. It is further stated that the combined steam and gas plant described will produce a net saving of 260 tons in propulsion equipment. If the writer's calculations are correct, this figure of 260 tons looks rather high.

Starting with an all-steam plant of 60,000 shp the "propulsion weight," using the authors' figures, will be

$$16 \times \frac{60{,}000}{2240} = 428 \text{ tons}$$

Now the plant is altered in the following fashion:

Half the boilers are removed.

Five gas turbines and one steam turbine replace one somewhat larger steam turbine.

The reduction gear is replaced by a larger gear with five instead of two pinions and with a complicated frame.

Size of auxiliaries and condensers is reduced somewhat and the net savings estimated are 260 tons out of 428. It would appear that a figure between 100 and 125 tons would be more likely. Furthermore, if a steam plant of 1940 vintage is being compared with a combined plant of 1952 vintage, the improvements now being made in steam power equipment are being deprecated.

In any case, however, a reduction in machinery weight of the order of 100 tons combined with substantial fuel savings is an important gain.

COMMENT BY OSCAR W. SCHEY[8]

The efficiency and the power output of engines, referred to in this paper, increase with the expansion ratio and the temperature of the working medium. Because the heat is applied directly to the working fluid in the gas turbine and not indirectly as in the steam turbine, the gas turbine has greater potentialities for high efficiency and power output than the steam turbine. The efficiency of the gas and steam turbine is about the same at about 1100 to 1200 F, the maximum temperature for present-day steam turbines, whereas gas turbines are now operating at inlet gas temperatures of 1500 F, or slightly higher. Furthermore, if cooling is provided for the hot blades, a gas turbine can be operated at appreciably higher temperatures than 1500 F. It is the writer's opinion, based on a large amount of analytical and experimental results, that present-day gas-turbine inlet temperatures can be increased greatly by the use of air-cooling, but liquid-cooling will be more desirable for obtaining very high temperatures.

Figs. 1, 2, and 3 of this discussion, show what can be gained theoretically in operating gas-turbine engines at high pressure ratios and temperatures. In addition to the conditions noted in the figures, the calculations are based on instantaneous specific heat; that is, variable γ. Fig. 1 shows that the

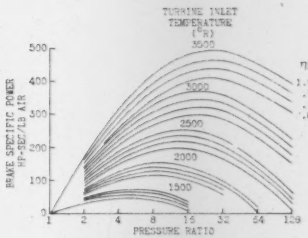


FIG. 1 SPECIFIC POWER OUTPUT AT SEA LEVEL WITH VARYING TURBINE EFFICIENCY (Compressor efficiency, 0.90; combustion efficiency, 0.95; pressure loss through burner, 0.05; no heat loss.)

specific power output will increase from 128 to 320 hp as the turbine-inlet temperature is increased from 2000 to 3000 F. If the temperature is increased to 3500 R, the specific power increases to 437 hp, about 240 per cent for the same weight of working fluid. The horsepower values in each case are taken at the optimum pressure ratios.

Fig. 2 shows the fuel consumption for the same conditions as the power curves in Fig. 1. Fig. 3 shows composite curves of results presented in Figs. 1 and 2, in which the specific power is plotted against the specific fuel con-

[7] Commander, USN, Naval Boiler and Turbine Laboratory, Naval Base, Philadelphia, Pa. Mem. ASME.

[8] Lewis Flight Propulsion Laboratory, NACA, Cleveland, Ohio. Member of ASME Compressor Committee.

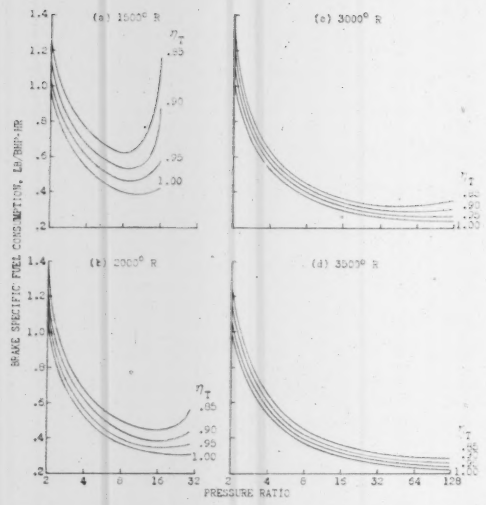


FIG. 2 SPECIFIC FUEL CONSUMPTION AT SEA LEVEL WITH VARYING TURBINE EFFICIENCY
(Compressor efficiency, 0.90; combustion efficiency, 0.95; pressure loss through burner, 0.05; no heat loss.)

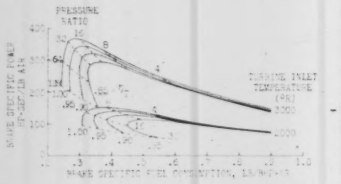


FIG. 3 CROSS-PLOT OF BRAKE SPECIFIC FUEL CONSUMPTION AND BRAKE SPECIFIC POWER AT SEA LEVEL WITH VARYING TURBINE EFFICIENCY
(Compressor efficiency, 0.90; combustion efficiency, 0.95; pressure loss through burner, 0.05; no heat loss.)

sumption for temperatures of 2000 and 3000 R. The effect of component efficiency (turbine or compressor) at any given inlet temperature is small at pressure ratios less than 8; the effect increases appreciably as the pressure ratio is increased. These curves show very decidedly the direction in which the greatest gain can be obtained, and indicate the remarkable potentialities for very high power and extremely low specific fuel consumption. No type of power plant offers such encouraging possibilities for combining high power and low specific fuel consumption as the gas-turbine engine operating at high pressure ratios and high temperatures.

To those who are inclined to be more conservative in their thinking, the writer would suggest that they take a realistic view in the light of the progress that has been made during the last 10 or 15 years. We now have compressors of about 85 per cent adiabatic efficiency, and turbines a few per cent higher; these values are about 10 per cent higher than could be obtained 15 years ago. In the same period, heat-resisting alloys have improved to the extent that temperatures at least 300 F higher can be obtained. Furthermore, the aircraft industry, the military, and other government establishments are expending a tremendous effort in research and development on centrifugal, axial, and supersonic compressors. Turbine research and development is also being prosecuted vigorously. A large amount of energy is also being expended on turbine cooling with fruitful and very encouraging results. The authors have kept abreast of current research and development work and rightfully recognize the advantage of applying the gas-turbine engine to naval propulsion.

There is a great deal of research and development work to be done before we will have a high-pressure-ratio and high-temperature gas-turbine engine, but let us direct our efforts along these lines in order that the time may be reduced. We are very fortunate in one respect—that the fundamental information obtained on compressors and turbines and turbine cooling in developing aircraft power plants can be used for power plants in naval propulsion. In the next few years we will see a gradual increase in pressure ratios and temperatures.

Liquid and air-cooling of gas turbines has been in progress for some time. Air-cooling has been most intensively investigated for aircraft power plants. Hollow blades, blades with inserts, finned blades, and blades of porous materials are being investigated. The results obtained indicate that turbine cooling should enable us to operate at appreciably higher temperatures than now employed with small cooling losses. Cooling also provides a means of conserving strategic materials and obtaining more dependable power plants.

The arrangement proposed by the authors should give a very flexible power plant that should make it possible to operate each unit near the design point, a very important consideration for maximum performance.

The authors are to be congratulated for their advanced thinking on naval power plants.

COMMENT BY C. R. WALLER[9]

The brief reference to the early history and development up to the present time is based upon facts and needs no comment.

The authors list "Special Requirements for Gas Turbines to Make Them Suitable for Navy Combat Ships." The five special items listed plus the four items common to customary ship power plants certainly give the engineers something at which to "shoot." In the writer's opinion, the problem under item (*B*) "Maneuverability," is by far the greatest challenge. Maneuverability when applied to Navy ships not only means maneuvering the ship in the harbor but means a power plant that must be used intermittently to supply power for the propeller over its entire speed range both ahead and astern. It also means that the power plant must be able to stop for a long or short period and at all times be ready for maximum power practically instantaneously. For this type of service the experience gained with stationary power plants has little value. Marine steam turbines presented the same problem 20 years ago when steam pressures and temperatures advanced from those previously considered normal. The problems increased materially when we approached the steam temperatures of 800 to 900 F which are now being used. The gas turbine with 1500 F adds to these complex problems.

A gas-turbine power plant using any

[9] Director of Engineering, De Laval Steam Turbine Company, Trenton, N. J. Fellow, ASME.

one of the cycles presently under consideration must include three major components; the compressor, the combustor, and the turbine. Each one must be of a type which will give an efficiency equal to or surpassing that considered acceptable for present commercial application. The writer believes the compressor end needs the greatest attention in so far as operating characteristics and efficiency are concerned, to make it suitable to fit into a gas-turbine power plant for Navy combat ships. Of the rotating type of compressor the mixed-flow shows possibilities. The writer's company for years has been experimenting with this type of compressor and now has under construction two sizes; 25,000 cfm and 50,000 cfm, each one built with three stages, giving a compression ratio of 6 to 1. These units operate without intercooling, and the expected efficiency and flatness of the operating characteristics should make them suitable for gas-turbine application. A special single-stage mixed-flow compressor has given a pressure ratio of over 7 to 1 with an efficiency of 72 per cent. We are also experimenting with an entirely new type of compressor based upon advanced studies in aerodynamics.

A compressor to fit into a Navy marine power plant must possess characteristics that maintain high efficiency over a wide range of flow so that operation in the pulsating zone is avoided. Recent research and experimentation have considerably widened the operating range on experimental units, but much more experimental work remains to be done.

The gas-turbine component is still in need of much lengthy and costly research and experimentation. The present state of the art is such that a gas turbine for marine service can be designed for and operated for extended periods of time at 1300 F initial temperature. The units that have already been built in this country and abroad definitely indicate that they must be handled with "kid gloves" with reference to starting and stopping, and would not fulfill the authors' special requirements. Further research will be needed in connection with distribution of metal masses and cooling.

The authors seem to have decided that liquid-cooling offers the best solution. In the writer's opinion this is disputable. Reciprocating airplane power plants developed during the last war faced the same disagreement among engineers and designers; namely, whether liquid-cooling should be used in preference to air-cooling. The fact remains that up to the present time the famous Pratt & Whitney Wasp Major engine is still in production and is still using air-cooling. Both experimental and theoretical studies have proved that air-cooled turbine blades have maintained satisfactory lower mean and maximum metal temperatures. In a recently published book by Professor Schlaifer he mentions ". . . one of these eventually accumulated 1000 hours of running time with inlet temperatures of 1800 F." The turbine wheel Professor Schlaifer refers to was of the centripetal type where the wheel and buckets were machined from a single forging of ATV_3 alloy using internal air-cooling. The use of liquid-cooling would add considerable complications, and it should be avoided until air-cooling is shown to be inadequate.

The data furnished in the paper outlining the maximum power demand in function of ship life is very interesting and may prove a very important reference for material selection, but it will not lessen the problem of designing a large-output gas turbine. New design complications to take care of temperature variations will occur when operating a sufficient length of time to reach sustained temperature levels. Using an open cycle a 30,000-hp gas-turbine plant, with present limited knowledge, will need approximately 450,000 cfm, requiring inlet ducts equal to one 100-in. pipe.

Before considering a gas-turbine power plant for a destroyer or other combat ship, it would seem more practical to concentrate first on a power plant for an auxiliary ship using less horsepower and somewhat easier operating requirements, and in that manner gain needed operating experience before tackling a "super-job."

The combination steam-and-gas-turbine propelling plant discussed by the authors is indeed a very interesting one, but it is felt that its possibilities barely scratch the surface of the potentialities of a combination cycle. To use the steam cycle in "parallel" with the gas-turbine cycle, at least from the point of view of fuel economy, is not nearly as attractive as using the gas-turbine cycle in "series" with the steam cycle. One possible arrangement of the in-series-type combination cycle, which has already been explored experimentally, consists of pressure-fired boilers in which the gas turbine, in addition to driving the boiler supercharging compressor, develops a substantial net power output. This arrangement permits operation of the gas turbine at relatively low temperatures, and was, therefore, a logical one at the time when much less was known about making a gas turbine suitable for operation with high initial temperature by means of blade cooling. Today the art has progressed to the point where initial temperatures for gas turbines can be used which result in exhaust temperatures sufficiently high to permit a compound cycle where the gas turbine operates at the higher temperature level and the initial temperature of the steam cycle corresponds to the exhaust temperature of the gas turbine. This latter compound cycle offers thermal efficiencies of the entire plant of the order of 40 to 50 per cent—far surpassing the thermal efficiencies possible with either the gas-turbine cycle or the steam cycle alone, or that of the reversed arrangement (steam cycle followed by gas cycle).

It is not too difficult to visualize an arrangement of the afore-mentioned gas-in-series-with-steam cycle which achieves the result that the authors consider important for the steam-parallel-gas cycle discussed in the paper, namely, the possibility of operating the steam plant for starting, maneuvering, or in emergency, independent of the gas turbine. For this purpose, the steam boilers (which are designed normally to convert the heat from the exhaust gases of the gas turbines into steam) can be provided with a separate burner arrangement so as to be fired as self-contained boilers, if necessary.

Dr. Morosoff,[10] chief gas turbine engineer with the author's company in Stockholm, has analyzed the combined steam-and-gas cycle and has provided sufficient thermodynamic calculations and curves to permit a close study. The figures indicate that the total fuel consumption of a ship requiring above 6000 shp would be less than 0.4 lb per shp.

The writer is fully in accord with the authors in the ultimate aim—that is, a gas-turbine power plant permitting initial temperatures of 2500 F or higher—but a great many steps will have to be taken before we reach this goal. At the present time, personally, he would not consider a gas turbine suitable for a Navy combat ship. The gas turbine is primarily a high-speed constant-flow machine and does not lend itself to the type of power plant to meet the authors' specifications. Just as a reminder, the steam-turbine era started in 1886, and to date, after 64 years, the geared-turbine marine power plant has only reached 850 F, and no suggestion has been made to raise this to 1300 F. Solving the problem of maneuverability is believed to be the answer.

[10] "Gas Turbine-Steam Turbine for Ship Propulsion," by Dimitry Morosoff, *Marine Engineering and Shipping Review*, vol. 55, May, 1950, pp. 40-47.

No study or development to approach the authors' specifications can be undertaken by any one manufacturer who in our economic setup is working for a living, but it should be undertaken by a government agency, assisted by the combined efforts of industry.

COMMENT BY R. C. ALLEN[11]

The authors are to be congratulated on a frank and instructive paper which contains numerous suggestions that indicate the possibilities of a favorable approach to the problem of propelling fighting ships of the Navy by gas turbines. Of particular value are the load and fuel-time curves given in Figs. 1 and 2 of the paper, which show clearly the service requirements of naval propulsion machinery and which also indicate the opportunities for weight and space occupancy reduction made possible by the appropriate consideration of life cycle under the high power conditions.

In the opening section of the paper the Allis-Chalmers gas turbine installed at the Experiment Station at Annapolis is mentioned. The Annapolis turbine tests have been the source of a great deal of valuable design information. One of the most important experiences was the development of the 16-25-6 Timken alloy, the determination of effective welding processes for the joining of disks of this material into a spindle structure, and the securing of blades to these disks by welding.

Other important experiences include the effect of cooling air on stationary elements, and particularly the difficulty of introducing cooling air in relatively heavy structures without setting up undesirable permanent deformations. The experience with cooling on the Annapolis turbine has indicated the direction in which designs must be improved in order to make use of the higher operating physical properties of the spindle materials available at lower temperatures while at the same time avoiding stress cycles in moving and stationary parts that might lead to undesirable permanent deformations.

The work at Annapolis also further emphasized the difficulties involved in building labyrinth seals which may safely rub under high-temperature conditions.

The authors direct attention to the requirements imposed on gas-turbine designs by the wide range of loads and speeds needed for the successful operation of naval propulsion plants. While the operating conditions in naval propulsion practice are quite different from the corresponding requirements imposed on stationary power plants, and other classes of power units, the design problems involved in aeronautical, locomotive, and stationary gas-turbine plants also include unusual operational specifications which in many respects impose restrictions on the design comparable with the problems that face naval propulsion-unit constructors.

Concerning maneuverability, the lightweight gas turbines for aircraft have demonstrated their ability to be started quickly, loaded, and stopped through many cycles without damage. The presently considered gas-turbine cycles with the operating pressures considerably lower than necessary for high-efficiency steam plants offer substantial advantages where the machinery is subjected to rapid changes of load and temperature. In spite of the high temperatures involved, the low cycle pressure makes possible the use of stationary casing parts that are relatively thin when compared to high-pressure steam-turbine practice. Methods are available for supporting rapidly expanding high-temperature parts to insure the radial expansion of such elements concentrically.

Regarding the economy of strategic materials, the authors properly direct attention to this problem as turbine designers employ alloys which contain high percentages of such elements as columbium, cobalt, tungsten, and others which are difficult to get in time of peace and still more so during a war. On the other hand, gas-turbine builders are forced by economic pressure to direct their peacetime efforts toward the elimination, to the maximum practicable extent, of the expensive and strategic materials. The commercial pressure on the cost of gas-turbine apparatus dictates that power-generation plants using such turbines have to be produced at a cost that is competitive. Commercial developments in this direction will be of direct aid in the construction of marine propulsion plants.

The authors mention the item of accessibility or ease of maintenance. It is the writer's opinion that maintenance is one of the most important problems confronting the gas-turbine user. In aircraft, propulsion units are removed from the airplane and replaced by a spare. If the maximum value of the gas turbine in the way of weight and space reduction is to be utilized in marine propulsion, units may well be built so that major maintenance will be by replacing a propulsion unit in a ship.

Concerning the comments on the various material studies at Annapolis and the Massachusetts Institute of Technology, it is desirable to mention here the great assistance rendered by various branches of the Government in providing manufacturers who are working on contracts for high-temperature rotating apparatus with reports of metallurgical research and development, particularly on high-temperature alloys. The wealth of information derived from these reports has been supplemental to the privately financed research, and has helped in many instances to provide information not otherwise available and at the same time essential to the projects under development.

The authors mention a considerable number of projects under way representing the design efforts of the gas-turbine manufacturers in this country. It is the writer's opinion that the importance of securing seagoing experience with a gas-turbine plant should not be underestimated. It is highly desirable that two types of gas-turbine plants be built and placed in service at the earliest possible date, one of the geared type connected to a reversible propeller instead of the ahead and astern elements employed in steam practice. The second plant should be of the electric-drive type. In view of the possibilities offered by the gas turbine for naval equipment, the writer can visualize no better expenditure of public money than to have built a plant of each of the two types mentioned, followed by the extensive operation at sea with the ships so equipped.

The British Admiralty has installed a unit of the aircraft type on a coastal patrol boat and as a result they have acquired some actual operating experience with a marine gas-turbine plant.

In constructing such plants for installation on shipboard, it is believed that an operating temperature of 1500 F can be adopted with an acceptable factor of reliability. Considerable experience has been acquired on turbines operating up to this temperature.

There is current speculation concerning plants to operate at temperatures in the region of 2000 F with gas or liquid cooling. Tests have been reported with a wheel of low-quality material at 2000 F although in that test the efficiency was relatively low. Comprehensive analyses have been made of turbine designs based on the mathematical treatment of the cooling problem. These developments indicate future promise in the direction of higher efficiency cycles but without

[11] Manager and Chief Engineer, Turbo-Power and Development Department Allis-Chalmers Manufacturing Company, Milwaukee, Wis. Mem. ASME.

definite schedules for early application of the advanced principles involved. The writer believes that it is imperative to get at least two gas-turbine propulsion plants in operation at sea at the 1500 F initial temperature level in order that extensive surveys may be made over a considerable period of time on all phases of the operation of this class of apparatus.

The description of the combined gas and steam-turbine plant indicates that there is great merit in a power unit of the type described with the possibility of a substantial reduction in space and weight. On the other hand, it would appear that the plant is complicated by the introduction of the steam-power machinery that must, under full power, operate in parallel with the gas-turbine elements. It is the writer's feeling that such a plant could be built with acceptable reliability and efficiency with gas turbines throughout.

Gas turbines for cruising conditions can be designed and built to operate on a relatively high-efficiency cycle which will include regeneration and intercooling, and possibly reheat.

The use of free-piston gas generators is mentioned as an interim possibility in relation to the operation of cruising components. This type of gas generator has been under development for many years, and it is believed that here also effective steps should be taken to demonstrate the reliability and practicability of multiple arrangements of small high-frequency free-piston compressors. These offer, in principle, a means of building cruising or auxiliary elements in which gas turbines may be employed for low powers at higher efficiency than is readily obtainable in the simple cycle gas-turbine plant with rotating elements throughout.

It is also believed that the authors are entirely correct in recommending the continuance of experimental work at initial temperatures in the region of 2500 F through the use of cooling for the hot turbine parts. It is not the writer's opinion that a good answer for the designer will be readily available in the near future through the cooling of blades and disks. On the other hand, it is believed that continued development has an excellent chance of bringing to light desirable design practice in these directions.

The last paragraph of the paper mentions compressor fouling. The closed cycle is a possible means of avoiding this difficulty but probably not necessary. It is well known that the main difficulty with such a cycle is the great size and weight of the heat-transfer elements. The writer is fully in agreement with the authors when they point out that continued study should be directed toward the discovery of heat-transfer elements of higher capacity than now available. Success in this direction will have innumerable applications.

At the present time the designer is faced with the need of quite comprehensive specifications for conditions under which full power is to be delivered. If allowances are made for compressor fouling, higher atmospheric air temperatures, and lower barometric pressures, the unit will provide power beyond full rating when compressors are clean, and air temperatures are lower and the barometer is higher. Variable-angle compressor blades have been used, and wet compression has been proposed. Future application studies must take full account of the various factors involved in determining the design capacity for propulsion service.

AUTHORS' CLOSURE

The authors wish to express their deep appreciation for the thoughtful discussions which were prepared concerning this paper, including not only those discussions which were read at the time the paper was presented, but those which could not be included owing to lack of time.

We are particularly grateful for Captain Gold's stimulating comments. That kind of encouragement and confidence has been one of the necessary ingredients of our own enthusiasm.

The question of relative noise level was raised by Captain Gold, and in connection therewith we wish to state that we believe that no very serious difficulty will be encountered in controlling this feature to the complete satisfaction of everyone concerned through use of suitable intake and exhaust silencers and other noise-suppression devices which the Bureau of Ships is investigating. Support of this contention is to be found in the published report[12] of the "smooth, almost silent performance" of the British gas-turbine-powered launch *Torquil*. We can cite the fact that the noise level for one small gas turbine recently developed under a Bureau of Ships contract was reduced from 120 decibels to 80 decibels with comparative ease and without significant loss in power or efficiency.

Mr. Hazen's comments are certainly pertinent and thought-provoking. We most assuredly agree with him that air cooling presents fewer problems than liquid cooling and that it should not be overlooked even for marine applications. We agree that for the time being and for the immediate future, air cooling should be utilized to the fullest extent. However, the fact that liquid cooling presents many difficult problems should not deter us in our quest for satisfactory solutions thereof. As Mr. Schey pointed out in his discussion, the gains to be realized from the utilization of very high temperatures and high pressure ratios are of such a spectacular nature, particularly with regard to those features of specific power (that is, available output per unit of weight and space required), fuel economy, and, very importantly, the economy of air through-put for which ducting must be supplied, that almost any amount of effort is justifiable in order to achieve them by liquid cooling. With high pressure ratios, the temperature of the air which is to be used for cooling is itself rather high to allow it to perform a proper cooling function. We agree with Mr. Hazen's comment that the problems involved in the utilization of higher pressure ratios are many, varied, and tough; however, as Mr. Hazen's own record attests, the progress which has already been made in gas turbines has not been made by dodging or ducking tough problems, and we do not believe that now is the time to begin ducking them.

Mr. Ireland requested the value of shaft horsepower which we used to represent the 20-knot cruising speed at which maximum economy is desired. We would like to quote the round figure of 5000 hp per shaft for that speed. The power required will, of course, depend upon loading, condition of bottom, special features of the underwater body, and so forth.

We agree with Mr. Ireland that much can be done with the steam plant in the direction of "overloading" to make it suitable for higher power with the retention of maximum economy at the 20-knot point, and we most assuredly intend to take advantage of the design schemes which he suggests. However, the upper figure of steam-turbine output was chosen as a limitation of boiler, piping, and pump sizes as much as it was for turbine and condenser sizes.

Mr. Ireland expresses the opinion that fewer booster units would require a smaller operating force with attendant saving in living-space requirements. Inasmuch as the operation of the gas-turbine units would be entirely automatic and the control would be from the single main throttle station where one man would operate the entire unit

[12] "Two Gas Turbines in a 60-Ft Launch," *The Oil Engine and Gas Turbine*, vol. 18, September–October–November, 1950, pp. 170–171.

in much the same manner as the throttleman operates an existing all-steam plant, we cannot agree that a smaller number of people would be required for a smaller number of booster units.

Commodore Kleinschmidt expresses the thought that we should develop the gas-turbine plant as a whole in an integrated design rather than to "patch it up out of available components." We most heartily agree with the Commodore in this respect. The statements in the paper to the effect that the plant which we proposed could be assembled within the framework of existing knowledge and already developed equipment applied to the basic components rather than the finished product. Most assuredly the gas turbines which are developed for this installation should be tailor-made for this specific job, but it is our contention that we now have the cloth, the thread, the buttons, the sewing machine, and the skilled tailors required to put this desired suit of clothes together.

The Commodore's objections to liquid-cooling are understood. As previously stated, we believe that the advantages to be gained are worth the effort in the finding of suitable solutions to the very considerable problems involved.

We are indebted to Mr. Allen for extricating us from the difficulties created by Mr. Law's inquiry regarding the maximum gas temperature attained on laboratory sets. We gratefully accept his stated figure of 2000 F, adding only that it is not the maximum attained.

Mr. Law suggests the study of pressure-fired combustion as a means of decreasing weight and space of propulsion equipment. We should like to assure him that very serious consideration has been given, and is now being given, to this type of installation. The Velox boiler has many advantages, as do many other types of high-pressure combustion boilers. These advantages are being explored with vigor by the Bureau of Ships. No doubt considerable improvement in existing steam plants could be realized through the use of pressure-fired combustion steam generators, but considerable development is required before suitable reliability will be attained.

Commander Meigs questions the estimated 260-ton weight saving which was quoted as a possibility. We hasten to admit that the figure used is subject to question, since it is the result of simple arithmetic based upon specific weights quoted in the paper rather than a thoroughgoing weight analysis of a modern plant. We will agree that the final saving in weight for the installation will be less than the 260 tons quoted, but we nevertheless contend that the final saving will be substantial and greater than 100–125 tons.

In connection with Mr. Schey's discussion, we should like to express our special gratitude for the new and hitherto unpublished information which he presented. This information confirms our thoughts about the advantages of high pressure ratios and high temperatures with great authority. We are reassured by Mr. Schey's support of the general philosophy underlying our proposals.

Mr. Waller states that a great deal of effort should be concentrated upon the development of suitable compressors and we should like to agree with him heartily in that comment. He also states that in his opinion we should concentrate on a power plant for auxiliary ships of less horsepower and somewhat easier operating requirements before tackling a "super job." In this connection we should like to emphasize that the very attractive advantages offered by the combined steam and gas-turbine plant may not be realized in a plant wherein the percentage of total power required for normal cruising condition is appreciably higher than that existing in high-powered naval vessels.

Mr. Waller also mentions another arrangement for combining steam and gas-turbine elements so as to gain a significant improvement in fuel economy. Such an arrangement is definitely worthy of study and serious consideration.

Mr. Allen's mention of the importance of low maintenance for any naval propulsion plants coincides with our own estimate of the situation and perhaps explains our basic preference for the simple open-cycle straight-through gas turbine. It is of interest to note that, in a study of certain available gas-turbine engines of from 50 to 1600 shp output, the heaviest part requiring lifting for minor or routine maintenance was found to be the compressor rotor assembly of the 1600-hp unit which weighed only about 130 lb. We agree that optimum weight and space reduction can be accomplished only by adoption of the principle of replacement when major maintenance is required. This is a practical course in view of the light weight of the complete units. For the variable-speed (or "split-wheel") engines referred to in our paper, we propose further to reduce the maintenance replacement time by incorporating a flexible quick-disconnect fitting between the gas-producer and power-output sections so that the former only may be replaced, leaving the output section undisturbed in its alignment with the output reduction gearing.

Action is being taken to provide the comprehensive naval gas-turbine specification which Mr. Allen requests. It will specify standard ambient conditions of 29.92 in. of mercury and 80 F and probably will not, at least initially, require allowance for component fouling.

The authors are deeply gratified by the interest shown in the subject discussed, and express their sincere appreciation of the fine criticisms, both positive and negative, which have been thoughtfully advanced.

R. T. SIMPSON.[13]
W. T. SAWYER.[14]

[13] Commander, U. S. N., Norfolk Naval Shipyard, Portsmouth, Va.
[14] Commander, U. S. N., Bureau of Ships, Navy Department, Washington, D. C.

Forest-Products Research

COMMENT BY HENRY CLEPPER[15]

The author has presented such a convincing case for increased research in the forest products industries[16] that no attempt will be made to supplement his arguments. Instead, a brief explanation will be given why the whole forestry profession has a valuable stake in increased wood research.

In any consideration of the utilization of wood, particularly in the form of lumber or lumber products, we must never forget the "kind" of resource with which we have to deal. The transition from old-growth to second-growth timber has been going on for three centuries and is nearly complete; roughly 80 per cent of the forest area of the United States is now second growth.

Silvicultural research is going forward in every major forest type to determine how second-growth stands and plantations should be managed so as to produce the largest volume and highest quality of timber.

We know that certain second-growth hardwoods—ash, elm, hickory, and oak, for example—yield a higher quality and stronger wood than old growth. Generally, however, second growth is decidedly inferior to old growth because of smaller size, wider sapwood, coarser

[15] Society of American Foresters, Washington, D. C.
[16] "Postwar Developments in Forest-Products Research," by C. A. Rishell, MECHANICAL ENGINEERING, vol. 72, October, 1950, pp. 805–808.

texture, and other reasons. Moreover, practically all second growth is lower both in quality and in volume than the original stands.

Thus, as the remaining stands of old growth continue to shrink, the forest-products industries must of necessity depend for their raw-material supply on lower-quality second growth. In consequence, we must face the fact that our utilization practices will have to be adapted to the use of low-grade timber.

Forest-products research is just as important to forestry as is silvicultural research. New developments in manufacture, such as in laminating and in plywood, permit the utilization of species that would otherwise be unsuited because of size and quality. In short, species formerly unused because of the density and strength of the natural wood will be increasingly utilized in modified form.

To sum up, two kinds of forest-products research can have a significant influence on improved forest management throughout the United States, namely, (1) research in the characteristics and properties of second growth of all species; and (2) research in utilization techniques to use low-grade timber more efficiently, and with less wastage both in the woods and in the mill.

Comparable to the Wood Industries Division of this Society is the Division of Forest Products of the Society of American Foresters. The foresters appreciate the opportunity to meet with the engineers. Through such meetings and through the exchange of knowledge, our two societies, working together, can do something which we both recognize is desirable, but which each working alone cannot accomplish; that is, to secure extensive industry participation in both basic and applied research aimed at the more efficient—and profitable—utilization of wood.

The Society of American Foresters is grateful also for the splendid co-operation rendered by this Society through the operations of the Joint ASME-SAF Committee on Equipment Development. This joint committee, organized at the request of the foresters to obtain more efficient tools and equipment for forest-fire control, has been in existence for five years.

Through the combined efforts of the engineers and foresters, numerous studies are going forward under the guidance of the committee for the improvement of devices necessary for the conservation of the nation's timber resources.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Reflections of a Physicist

REFLECTIONS OF A PHYSICIST. By Percy Williams Bridgman. Philosophical Library, Inc., New York, N. Y., 1950. Cloth, $5\frac{1}{4} \times 8\frac{1}{2}$ in., xii and 392 pp., $5.

REVIEWED BY JESSE ORMONDROYD[1]

THIS book consists of a collection of twenty-two papers written by Dr. Bridgman in the twenty years which lie between 1929 and 1949. The book takes its title from the fifteenth paper of the collection which is headed "Science and Freedom Reflections of a Physicist." If the reader wants to know what the man is who speaks to him, this paper should be read first. The paper contains some of the remarks made by the author at a dinner held in January, 1947, to honor him as the recipient of the Nobel Prize in Physics in December, 1946. In these remarks he outlines, in general terms, what he considered the significant aspects of his life's work. Freedom of investigation is the first condition to which he alludes with retrospective appreciation. The second outstanding characteristic which he sees in his work is the smallness of its scale. This permitted him to be in complete command of his works down to the least details of the work. The third characteristic which he notices is that his subject was not in a popular field. He had little competition, and he carried it on without much stimulating or critical discussion with other physicists. Fourthly, he points out that this field was narrow in the sense that pressure is a highly specialized parameter, but that it lead to the broad investigation of all the physical properties of materials which are affected by pressure. His personal distaste for large-scale co-operative enterprises among physicists is stated in no uncertain terms. Such activity, in his mind, eliminates all that he holds precious. Finally he criticizes the growth of administrative work for each important individual in large organizations—this to the detriment of the quiet, uninterrupted search for understanding in the individual's own field. Here we are given a picture of a strong individual who wishes to submit events to his own control, rather than to be controlled by them. The character of the man is mirrored in the contents of every paper in the collection.

If men can be classified, Bridgman would be called a classical physicist, a true successor to the creators of thermodynamic theory. Their work was similar to his in scale and individuality. In fact, outside of his own field thermodynamics seems to have been a favorite subject for him. While Bridgman worked in a snug little niche of his own, he liked to look out at the broader, more violent world of physics around him, and he liked to talk about what he saw. This side of him was the philosopher. Strangely enough, it is as a philosopher that he is best known to most engineers. Many engineers are familiar with his book on dimensional analysis, his critical discussions of thermodynamics and probability, and his book, "The Logic of Modern Physics."

The papers in the "Reflections" give in outline almost his entire philosophic interests in the broad characteristics of modern physics and indicate a strong interest in certain aspects of the social problem.

The author has presented his papers in five groups. The first group contains two papers which discuss operational analysis and two which discuss the relationship of the individual to society as seen in the light of operational analysis. "The essence of the 'operational'

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attitude is that the meaning of terms is to be found by an analysis of the operations performed in applying the term to concrete situations, in verifying the truth of statements, or in finding answers to questions." While this attitude was devised for use in physics, the author feels that "clarification might be expected in all situations in which obscurity of meanings is one of the factors with which we have to contend." Applying the operational analysis to science, the author finds that all the operations which give science any meaning are all "private." Such operations as apprehension of meaning, appraisal of significance, checking, judging, accepting can only be done by the individual himself. Further operational analysis reveals the severe isolation of the individual from the rest of creation.

The second group of six papers deals exclusively with the operational approach to the startling findings of modern physics. This group of papers will probably be the most interesting in the whole collection to engineers who may read the book. The changes necessary in our patterns of thinking brought about by the recent discoveries in atomic physics and relativity are discussed in this group.

The third group, captioned "Primarily Social," discusses intellectual integrity, the relationship between scientists and society, and ends with a paper in which the author doubts whether man is rational enough to develop a true social science.

The fourth group of four papers contains the author's criticism of totalitarianism and "sentimental" democracy. Perhaps the most important papers in the entire collection are those in this group entitled "The Prospect for Intelligence" and "New Vistas for Intelligence."

Bridgman is a writer of real charm. Every paper in the collection holds the reader's attention from beginning to end. Perhaps the enjoyment of reading these reflections comes from the frequent recognition of ideas which the reader himself has had in nebulous form, but which never reached such clear and cogent expression as is found here. Any engineer with the slightest philosophical interest will enjoy reading "The Reflections of a Physicist."

Books Received in Library

ASTM STANDARDS ON PETROLEUM PRODUCTS AND LUBRICANTS, prepared by Committee D-2; Methods of Testing, Specifications, Definitions, Charts and Tables. Published by American Society for Testing Materials, Philadelphia, Pa., November, 1950. Paper, 6 × 9 in.; cloth, 6 × 9 in.; 764 pp., illus., diagrams, charts, tables. Paper, $5.50; cloth, $6.15. This latest compilation of ASTM standards on petroleum products and lubricants contains 112 test methods, 8 specifications, 3 lists of definitions, and 2 tentative recommended practices. It covers crude petroleum, motor and aviation fuels, light hydrocarbons, tractor and Diesel fuels, hydrocarbon liquids, kerosene and illuminating oils, lubricating oils, turbine oils, electrical insulating oils, thermometers, plant spray oils and petroleum sulphonates, greases, petrolatums, and paraffin waxes. Methods of test for rating fuels are also included.

ADVENTURE INTO THE UNKNOWN. By L. A. Hawkins. William Morrow & Company, New York, N. Y., 1950. Linen, $6^1/_4 \times 9^1/_2$ in., 150 pp., illus., $3.50. This book surveys the first fifty years of work done at the General Electric Research Laboratory. It describes the character of the laboratory, its methods and objectives, the diversity, range, and significance of its projects, and the personal characteristics of some of its leaders. Some of the individual accomplishments discussed are Dr. Irving Langmuir's work with incandescent lamps, early vacuum tubes, and weather research; Dr. Albert Hall's studies in electronics; and Dr. Saul Dushman's researches into high vacuum.

AERODYNAMICS OF SUPERSONIC FLIGHT. By A. Pope. Pitman Publishing Corporation, New York, N. Y.; Toronto, Canada; London, England, 1950. Cloth, 6 × $9^1/_4$ in., 184 pp., illus., diagrams, charts, tables, $4. An undergraduate text for an introductory course in supersonics. The treatment is nonthermodynamic in nature, but requires a knowledge of the calculus and elementary aerodynamics. Fundamental relations are developed and then applied to flow in a duct, two-dimensional flow, oblique shock, approximate theories, supersonic wind tunnels, and three-dimensional flow.

AIRCRAFT DESIGNERS' DATA BOOK. By L. E. Neville. McGraw-Hill Book Company, Inc., New York, N. Y.; Toronto, Canada; London, England, 1950. Cloth, $8^1/_2 \times 11^1/_4$ in. 534 pp., illus., diagrams, charts, tables, $10. Based on material published in the periodicals, "*Aviation*" and "*Wings*," and on data supplied by manufacturers, this handbook provides a graphic presentation of detail designs of a selected group of typical domestic and foreign aircraft and power plants. The 788 illustrations and sketches with text are arranged in chapters corresponding to the basic components of the aircraft. Pertinent data are given on wing and auxiliary surface design; empennage design; fuselage, body, and hull design; landing-gear and control-system design; rotating-wing aircraft; and turbine engines.

AMA HANDBOOK OF WAGE AND SALARY ADMINISTRATION, Tested Compensation Methods for Factory, Office and Managerial Personnel. Edited by M. J. Dooher and V. Marquis. American Management Association, New York, N. Y., 1950. Linen, 6 × $9^1/_4$ in., 412 pp., diagrams, charts, tables, $7.50. Integrating material published by the Association, this manual is a complete survey of the principles and techniques of wage and salary administration and of management's experience in their day-to-day application. It also contains the new AMA research material on wage surveys, union contract provisions covering office-salary administration, job-evaluation forms, and a bibliography. A model manual used by a company to explain its wage program to employees is reproduced in its entirety as an appendix.

ECONOMICS OF AMERICAN INDUSTRY. By E. B. Alderfer and H. E. Michl. Second edition. McGraw-Hill Book Company, Inc., New York, N. Y.; Toronto, Canada; London, England, 1950. Linen, 6 × $9^1/_4$ in., 716 pp., illus., diagrams, charts, tables, $5.50. Revised and brought up to date, this second edition reflects the technological and structural changes which have taken place since the first edition was published in 1942. Industries included are: metal and metal fabricating, nonmetallic minerals, chemicals, petroleum, rubber, textiles, apparel, food, etc. For each industry, the latest available data are provided to indicate changes in productive capacity, shifts in location, development of new industrial areas, and additional manufacturing facilities.

ECONOMICS OF FUEL GAS FROM COAL. By Battelle Memorial Institute; J. F. Foster and R. J. Lund, editors for Bituminous Coal Research. McGraw-Hill Book Company, Inc., New York, N. Y.; Toronto, Canada; London, England, 1950. Linen, 6 × $9^1/_4$ in., 289 pp., diagrams, charts, tables, $5. This book contains the results of a survey undertaken by Battelle Memorial Institute for Bituminous Coal Research, Inc. Divided into two main parts, the first deals with the technical aspects of fuel-gas production and includes available data on operating costs, maintenance, and investment cost of gasification processes, and on research. The second part assembles data on costs of transporting various fuels, and discusses supplies, demand, and past prices. From these and other data, future price trends for each fuel are predicted.

FUNDAMENTALS OF QUANTUM MECHANICS. By E. Persico, translated and edited by G. M. Temmer. Prentice-Hall, Inc., New York, N. Y., 1950. Linen, $5^1/_2 \times 8^3/_4$ in., 484 pp., diagrams, charts, tables, $8. In this book are presented the fundamental laws and principles of quantum mechanics, together with some applications. The first part provides an historical, over-all view of the evolution of quantum mechanics using an intuitive and elementary approach. The second part, preceded by a mathematical introduction, considers the principles of the wave mechanics of a particle. In the third and last part the transformation theory is developed, more advanced mathematical methods are used, and applications are considered.

GERMAN-ENGLISH TECHNICAL AND ENGINEERING DICTIONARY. By L. De Vries. McGraw-Hill Book Company, Inc., New York, N. Y.; Toronto, Canada; London, England, 1950. Cloth, 6 × $9^1/_4$ in., 928 pp., $20. Covering all fields of engineering and technology, this new book contains more than 125,000 entries, including many new words taken from glossaries compiled by various research workers and translators for their own use, now available in book form for the first time. There is a 36-page alphabetical list of German abbreviations, with their English equivalents, at the end of the volume.

HOW TO CHART TIMESTUDY DATA. By P. Carroll. McGraw-Hill Book Company, Inc.,

New York, N. Y.; Toronto, Canada; London, England, 1950. Cloth, 6 × 9¼ in., 323 pp., diagrams, charts, tables, $5. Of value to industrial engineers and shop executives, this book deals with the fundamentals and methods of charting time-study data. Following a discussion of incentives and the cost of time study, the standard data method is considered. Curve drawing, alignment charts, time-study equations, multiple curves, preferred numbers, and various methods of charting time-study data are then considered.

INTRODUCTION TO THE CALCULUS OF VARIATIONS. By C. Fox. Oxford University Press, New York, N. Y.; Geoffrey Cumberlege, London, England, 1950. Cloth, 5½ × 9 in., 271 pp., diagrams, tables, $4.50. Covering principles and techniques, the first two chapters of this new text deal with the first and second variation of an integral. The remainder of the book includes a study of isoperimetrical problems, Hamilton's principle and an account of its application to the special theory of relativity, the principle of least action, approximation methods with applications to problems of elasticity, and an account of the Weierstrassian theory of strong variations based upon the work of Hilbert. A knowledge of partial differentiation and differential equations is assumed.

JET PROPULSION TURBOPROPS. By V. C. Finch. National Press, Millbrae, California, 1950. Fabrikoid, 5½ × 8¾ in., 256 pp., illus., diagrams, charts, tables, $5. This book is a collection of recent applications of generic principles to the development, design, construction, operation, and evaluation of the turboprop. It also includes standards and practices as applied to turboprops. There are many illustrative examples with completed solutions, but no problems are included. These and answers may be obtained gratis by instructors adopting the text.

LAPLACE TRANSFORMATION, Theory and Engineering Applications. By W. T. Thomson. Prentice-Hall, Inc., New York, N. Y., 1950. Linen, 5¾ × 8¾ in., 230 pp., diagrams, charts, tables, $5. Following introductory material, the properties and dynamical and structural applications of the Laplace transformation are discussed. The theory of complex variables is reviewed to aid in the understanding of applications involving partial differential equations and difference equations. A variety of such applications including the field of closed-loop systems are considered. The closing chapter discusses two types of mechanical-electrical analogies frequently used in analysis.

MUNICIPAL AFFAIRS. By E. W. Steel. Second edition. International Textbook Company, Scranton, Pa., 1950. Linen, 5¼ × 8½ in., 377 pp., diagrams, charts, tables, $5.50. This book combines a discussion of the fundamentals of city government with functions of the various departments and technique of administration. Special attention is given to problems of utilities including those municipally owned. One chapter is devoted to city planning. In this second edition, new techniques and statistics are added to conform with present conditions and recent developments in the financing of city improvements.

POWER SYSTEM STABILITY, Volume II. Power Circuit Breakers and Protective Relays. By E. W. Kimbark. John Wiley & Sons, Inc., New York, N. Y., and Chapman & Hall, Ltd., London, England, 1950. Linen, 6 × 9¼ in., 288 pp., illus., diagrams, charts, tables, $8. This is the second volume of a three-volume work intended for use by power-system engineers and by graduate students. The present volume covers power circuit breakers and protective relays, including material on rapid reclosure of circuit breakers and on performance of protective relays during swings and out-of-step conditions. Both three-pole and selective-pole tripping and reclosure are discussed. Numerous references and a set of problems are included at the end of each chapter.

SAFETY IN ELECTRIC AND GAS WELDING AND CUTTING OPERATIONS. (American Standard Z49.1-1950). American Welding Society, New York, N. Y., 1950. Paper, 6 × 9 in., 42 pp., tables, $.50. This standard covers regulations for safe installation and operation of welding equipment for arc, gas, and resistance-welding processes. Provisions are included for fire prevention and protection in regularly assigned welding areas and in other locations as well. The protection of personnel is treated from the standpoint of the welder, for whom eye protection and clothing requirements, health protection, etc. are prescribed, and from the standpoint of other workers in areas adjacent to welding operations. Precautions are specified for the welding of materials which may give off toxic fumes and for welding in confined areas.

ASME BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly, to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

(The following Case Interpretations were formulated at the Committee meeting December 15, 1950, and approved by the Board February 8, 1951.)

CASE No. 994 (REOPENED)*

(Special Ruling)

Add at end of reply:

(5) "In view of the fact that this alloy is not one of those which suffer loss of impact resistance at low temperatures, the requirements of Pars. U-140 to U-142, inclusive, shall not apply."

CASE No. 1037 (REOPENED)

(Special Ruling)

Inquiry: (a) May corrosion-resistant steel sheet or plate be used in constructing cylindrical shells, heads and cylindrical combustion chambers of low-pressure steel heating boilers, and if so, how shall the minimum thickness of such parts be calculated?

(b) May corrosion-resistant steel fire tubes be used in low-pressure heating boilers, and if so, how shall the minimum thickness be calculated?

Reply: (a) Cylindrical shells, heads, and cylindrical combustion chambers in low-pressure steel heating boilers may be made from corrosion-resistant steel under the following rules:

(1) The steel shall comply with Specification SA-240, Grade S, M, T, or C; or with specification SA-167, Grade 3, 5, or 11.

(2) The welding shall be done under a procedure and by welding operators qualified according to Section IX of the Code.

(3) The thickness of the shell shall be calculated according to Par. H-4 of the Code using specified minimum tensile strength shown in Table P-7 of the Code, and with joint efficiency 80%, but in no case thinner than #12 stainless sheet gage (0.125 in.). The thickness of the heads or tube sheets shall be not less than shell thickness plus 1/16 in., and for rolled tube construction the minimum thickness shall be 5/16 in. The thickness of the combustion chamber shall be calculated according to Par. P-241 of the Code, but in no case thinner than 1/8 in.

(4) The maximum out-of-roundness of the cylinder shall be as specified in Par. U-125 of the Code.

(5) The maximum diameter of the shell shall be 36 in. and of the combustion chamber shall be 18 in.

(b) The fire tubes in low-pressure heating boilers may be made from corrosion-resistant steel under the following rules:

(1) The material shall be a Code material and the tubes shall be manufactured by a process recognized by Code specifications.

(2) The thickness of the material shall be calculated according to the formula in Table P-4 of the Code but in no case less than 2 gage thicknesses below

* Applies to 1949 UPV Code only.

the minimum specified for steel tubes in Table H-3 of the Code.

(3) Tubes may be installed by rolling and flaring or by welding. If by welding, the operation shall be done under a procedure and by a welding operator qualified under Section IX of the Code.

CASE No. 1123

(Interpretation of Par. H-83)

Inquiry: In the manufacture of welded steel heating boilers, will the stay welding under Par. H-83 be acceptable if dimensions of the weld comply with the specified area in shear although the size of the weld may be less than the plate thickness? Tests run with the co-operation of our authorized inspection agency have demonstrated that this stay welding will stand a pressure more than five times the maximum working pressure of the boiler.

Reply: It is the opinion of the Committee that the welding of stays may be considered as complying with Par. H-83 (1) if the area of the weld in shear measured parallel to that portion of the stay in or extending through the plate is not less than 1.25 times the required cross-sectional area of the stay.

(The following Case Interpretations were formulated at the Committee meeting January 26, 1951, and approved by the Board March 9, 1951.)

CASE No. 1114

(Referring to 4S Aluminum)

Inquiry: Will unfired pressure vessels fabricated by fusion welding under the general requirements of Pars. U-68, U-69 and U-70 meet the intent of the Code if the base material is aluminum-manganese-magnesium alloy MG11A of Specification SB-178* and/or ASTM B-210*?

Reply: It is the opinion of the Committee that the aluminum-manganese-magnesium alloy MG11A described in Specification SB-178 may be used for the construction of unfired pressure vessels under the condition that:

(1) Sheet and plate meet the applicable requirements of Specification SB-178.

(2) Tubing meets the applicable requirements of ASTM Specification B-210 and the tensile strength is not less than 23,000 psi and the yield strength not less than 8,500 psi.

(3) The minimum yield strength of plate, sheet or tubing conforming to the above specifications is not less than the following:

Temper	Yield strength psi (0.2 per cent offset)
O	8,500
H 32	21,000
H 34	25,000
H 112	9,000

(4) Fabrication is by fusion welding using electrodes complying in composition with SB-184 electrode classification AL-2, AL-43 or electrodes of the same composition as the parent material. When Type AL-2 electrodes are used, the welded joints shall not be stresses higher than the level permitted for SB-178 aluminum-manganese alloy M-1, reduced by the welding efficiency factor. For the joints welded with the other electrodes, the stresses allowed for the parent plate may be used as modified by the welding efficiency. When welding rod AL-43 is used for main seams, it is not permissible to have openings or welded connections in or adjacent to those seams within a distance of three plate thicknesses; furthermore, the design shall be such that except for the discontinuity stresses at head to shell joints, the main longitudinal and circumferential joints are subject only to direct (membrane) stresses due to pressure and free of all stress raisers. Welding rod AL-43 shall not be used for welding connections into the vessel wall. The general rules of Pars. U-68, U-69 or U-70 shall be followed. In addition to the general rules of Par. U-69, portions of the completed welded joints shall be examined either by spot radiographing, by sectioning, or by a combination of both methods. The welds shall meet the standards outlined in Par. U-208, until such time as acceptable standards are developed and approved for aluminum-alloy welds. The requirements of Par. Q-109, Note C and the Note in Par. Q-209 shall apply to vessels constructed under the rules of Par. U-68.

(5) The welding requirements of Section IX and the applicable paragraphs apply, except that:

(*a*) The tensile strength of the reduced section tension specimens shall be not less than 23,000 psi when using the high tensile welding rods, and 14,000 psi when AL-2 welding rod is used.

(*b*) The elongation as determined by the free-bend test shall be not less than 8 per cent for welds made with SB-184-AL-43 rods, and not less than 15 per cent for welds made with rods of the same composition as the parent metal or with SB-184-AL-2 rods.

(*c*) Qualification tests made on a given thickness of material shall apply to thicknesses varying as much as ±50 per cent from that thickness. Not more than two thicknesses need be qualified. They shall include the minimum and maximum thicknesses under consideration.

(6) The following maximum allowable working stresses are to be used in applying the design rules where reference is made to Table U-3 or Table U-2:

	Metal temperature not exceeding degrees F						
Temper	100	150	200	250	300	350	400
O	5650	5650	5650	5500	4650	3850	3150
H 32	7000	7000	6700	6050	5300	4500	3750
H 34	8000	8000	7600	6900	6100	5200	4350
H 112	5750	5750	5750	5500	4650	3850	3150

(7) For welded joints, the allowable working stresses for annealed material are used.

(8) For U-70 construction, the joint efficiency to be used in applying the design rules is taken as the ratio of the SE values given in Pars. U-70(a) and (b) divided by 11,000.

(9) Thermal stress-relieving is not required.

(10) In view of the fact that this alloy is not one of those which suffer loss of impact resistance at low temperatures, the requirements of Pars. U-140 to U-142, inclusive, shall not apply for service above —325 F.

(11) In the hydrostatic test, the test pressure is not less than 1.5 times the maximum working pressure.

(12) Bolting materials conform to alloy and temper of GS11A-T6 or CG42A-T4 of ASTM Specification B-211, or to one of the grades of alloy steel of Specification SA-193. The allowable working stresses for GS11A-T6 and CG42A-T4 are as follows:

	Metal temperature not exceeding degrees F						
Material	100	150	200	250	300	350	400
GS11A-T6	7000	6700	6450	5900	5000	4000	2900
CG42A-T4	8000	7750	7500	7200	6200	4900	3650

CASE No. 1122

(Special Ruling)

Inquiry: May the extra low carbon grades of the austenitic stainless steels Types 304, 316, and 317 be used under the applicable Code rules pertaining to the regular grades of austenitic stainless steels?

Reply: It is the opinion of the Committee that the extra low carbon grades

* Alloy MG11A is included by 1950 revision.

of Types 304, 316, and 317 may be used for construction under the Code rules applying to the regular grades of Types 304, 316, and 317 with the following modifications:

(1) The material shall conform to the requirement of an approved specification which covers the same grade with regular carbon content, except that:

(*a*) The carbon content shall be limited to 0.03 per cent max.

(*b*) The mechanical properties shall be as follows:

Tensile strength—70000 psi. min.
Yield strength—25000 psi. min.
Elongation in 2 in.—as required by specification

The following stresses are to be used:

Alloy Material (ELC)	Spec. Min. Tensile	−20 to 100	200	300	400	500	600	650	700	750	800
Type 304 (T.S.)*	70000	17500	17000	16000	15000	14000	13000	12500	12000	11500	11000
Type 304 (Y.S.)	70000	17500	17000	13400	11000	9700	9000	8750	8500	8300	8100

Alloy Material	Spec. Min. Tensile	−20 to 100	200	300	400	500	600	650	700	750	800
Type 316 (T.S.)*	70000	17500	17500	15800	14750	14000	13600	13450	13250	13000	12700
Type 316 (Y.S.)	70000	17500	17500	14500	12000	11000	10150	9800	9450	9100	8800

* These stresses are permitted when distortion can be permitted without endangering the safety of the structure.

CASE No. 1124

(*Special Ruling*)

Inquiry: May the shells of pressure vessels complying with Par. U-69 of the 1949 Section VIII and with Par. UW-52(b) of the 1950 Section VIII be constructed of resistance-welded pipe not over 0.58 in. thick or 30 in. in diameter, made by the electric-furnace or open-hearth process complying with Specification API Standard 5L, Grade C 1949, for which the minimum tensile strength is 75,000 psi?

Reply: It is the opinion of the Committee that resistance-welded pipe may be used within the limitations given in the inquiry for shells of pressure vessels, provided the chemical composition of Specification API Standard 5L, Grade C 1949, be modified as follows:

Carbon: max. 0.30 per cent
Manganese: 0.85 to 1.25 per cent

The allowable stress to be used in Table U-4 of the 1949 Section VIII is 12,750 psi and in Table UG-27 of the 1950 Section VIII, is 15,950 psi, both with temperature not exceeding 650 F.

CASE No. 1125

(*Interpretation of Par. U-206*)

Inquiry: Par. U-206(a) does not include conical heads and conical shell sections among those parts for which increased design stresses are permitted. On the other hand, Par. U-206(b) does not specifically list these parts among those for which the increased design stresses are not permitted. In view of this inconsistency, what is the proper status of conical heads and conical shell sections when used in fusion welded pressure vessels built in accordance with Pars. U-200 and U-201?

Reply: When the rules for conical heads were added to Par. U-36, clarification of their status under Par. U-206 was inadvertently overlooked. It is the opinion of the Committee that conical heads and conical shell sections under internal pressure may be included among the parts in Par. U-206(a) for which increased design stresses may be used.

CASE No. 1127

(*Special Ruling*)

Inquiry: Is it permissible under the Code to use copper-silicon alloys conforming to SB-96, Type A and SB-98, Type A, except that the maximum silicon content is increased from the present 3.5 per cent to 3.85 per cent?

Reply: It is the opinion of the Committee that the copper-silicon alloys defined in this inquiry may be used in accordance with the existing rules if the silicon content is within the range of from 2.8 to 3.6 per cent, rounded, and the manganese content is within the range of from 0.50 to 1.35 per cent.

CASE No. 1128

(*Special Ruling*)

Inquiry: May the stress values given in revised Table UG-23 for carbon and low alloy steels and those in Section UHA for high alloy steels be used for superheater tubing under Section I?

Reply: It is the opinion of the Committee that pending general revision of the stresses in Table P-5, the stress values given in revised Table UG-23 and those in Section UHA may be used. When using the stresses in Table UG-23 and Section UHA for superheater tubes under Section I, they must first be multiplied by 80 per cent before using them in the tube formulas of this Section.

CASE No. 1129

(*Special Ruling*)

Inquiry: May 1 1/4 per cent chromium, 1/2 per cent molybdenum wrought materials, conforming to Specification SA-158, Grade P-11, be used for steam piping under Section I at the following stresses:

For temperatures not exceeding degrees F:

−20 to 650	700	750	800	850
12000	12000	12000	12000	11500
900	950	1000	1050	1100
10500	8800	6250	4400	3200

Reply: It is the opinion of the Committee that pending general revision of the stresses in Table P-5, the stresses listed in the inquiry may be used in construction under Section I of the Code.

Proposed Revisions and Addenda to Boiler Construction Code

AS need arises, the Boiler Code Committee entertains suggestions for revising its Codes. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennally the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code. Simple changes are indicated directly. In the more involved revisions added words are printed in SMALL CAPITALS; deleted words are enclosed in brackets[]. Comments should be addressed to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.

Power Boilers 1949

PAR. P-6. In third line, change "SA-7" to "SA-307."

TABLE P-7. In Specification number column under Bolting, Carbon Steel, change "SA-7"

to "SA-307", followed by "B" in the Grade column.

PAR. P-257(b). Add as new paragraph:

The inner buttstraps in locomotive type boilers may be seal welded, provided the plates do not exceed 0.35 per cent carbon, the weld metal is deposited in a single layer having a weld size less than $^3/_8$ in., and the weld metal is deposited in accordance with the method provided for attaching nonpressure parts in the second paragraph of Par. P-186(e).

PAR. P-296. Insert as third sentence:

For boilers carrying 500 lb pressure or over, valves may be used in place of cocks.

TABLE P-15. Revise first sub-heading, to read:

ADJUSTED PRESSURE RATINGS FOR CARBON STEEL FLANGES AND FLANGED FITTINGS AND VALVES

PAR. P-300 (4). Revise line 28 as follows:

Upon completion of the work a data report form P-4A shall be executed in accordance with Par. P-332.

PAR. P-332. Change present "(d)(4)" and "(5)" to "(5)" and "(6)" and add a new "(4)" as follows:

(4) Manufacturers' data report form P-4A* shall be used to record all shop or field welded piping within the scope of this Code, Section I.

Low Pressure Heating Boilers 1949

PAR. H-83(1). Delete and substitute:

The stays shall be inserted into holes through the sheets except as provided in (3). The size of the weld in shear, measured parallel to that portion of the stay in or extended through the plate shall be not less than $^5/_{16}$ times the required diameter of the stay, and in no case less than $^1/_4$ inch. For a stay with other than circular cross section the minimum size of weld shall be that calculated for a circular stay of the same cross-sectional area. To provide for the above specified welding, the plate may be countersunk by machining or pressing, or the stay may protrude through the plates, or a combination of those methods may be used. The end of the stay shall not be covered by weld metal and shall not be below the surface of the plate.

PAR. H-104(e). Revise third sentence as follows to agree with Par. H-51(e):

Relief valves for hot-water boilers shall be tested at full capacity at 3 psi over the set pressure.

Unfired Pressure Vessels 1949

TABLE U-2. In Material and specification number column under Bolting, Carbon Steels, change "SA-7" to "SA-307," followed by "B" in the Grade column.

Unfired Pressure Vessels 1950

TABLE UG-23. Substitute the following revised figures for the specifications indicated and the revised footnote (4) for the present one:

TABLE CORRECTIONS

Specification Number	Grade	Spec Min Tens	Notes	For Metal Temperatures not exceeding deg F: −20 to 650	700	750	800	850	900	950	1000
Plate											
SA-30	A	55000	(1)(4)	13750	13250	12050	10200	8350	6500		
SA-30	B	48000	(4)	12000	11650	10700	9300	7900	6500		
SA-201	A	55000		13750	13250	12050	10200	8350	6500	4500	2500
SA-201	B	60000		15000	14350	12950	10800	8650	6500	4500	2500
SA-202	A	75000		18750	17700	15650	12600	9550	6500	4500	2500
SA-202	B	85000		21250	19800	17700	12800	9900	6500	4500	2500
SA-203	A, D	65000		16250	15500	13850	11400	8950	6500	4500	2500
SA-203	B, E	70000		17500	16600	14750	12000	9250	6500	4500	2500
SA-203	C	75000		18750	17700	15650	12600	9550	6500	4500	2500
SA-212	A	65000		16250	15500	13850	11400	8950	6500	4500	2500
SA-212	B	70000		17500	16600	14750	12000	9250	6500	4500	2500
SA-285	A	45000	(1)(4)	11250	11000	10250	9000	7750	6500		
SA-285	B	50000	(1)(4)	12500	12100	11150	9600	8050	6500		
SA-285	C	55000	(1)(4)	13750	13250	12050	10200	8350	6500		
SA-299		75000	(10)	18750	17700	15650	12600	9550	6500	4500	2500
Pipes and Tubes											
SA-53	A	48000	(4)	12000	11650	10700	9300	7900	6500	4500	2500
SA-53	B	60000	(4)	15000	14350	12950	10800	8650	6500	4500	2500
SA-83	A		(4)	11750	11450	10550	9200	7850	6500	4500	2500
SA-106	A	48000		12000	11650	10700	9300	7900	6500	4500	2500
SA-106	B	60000		15000	14350	12950	10800	8650	6500	4500	2500
SA-192				11750	11450	10550	9200	7850	6500	4500	2500
SA-210		60000		15000	14350	12950	10800	8650	6500	4500	2500
Forgings											
SA-105	I	60000	(4)	15000	14350	12950	10800	8650	6500	4500	2500
SA-105	II	70000	(4)	17500	16600	14750	12000	9250	6500	4500	2500
SA-181	I	60000	(4)	15000	14350	12950	10800	8650	6500	4500	2500
SA-181	II	70000	(4)	17500	16600	14750	12000	9250	6500	4500	2500
SA-266	I	60000		15000	14350	12950	10800	8650	6500	4500	2500
SA-266	II	70000		17500	16600	14750	12000	9250	6500	4500	2500
SA-266	III	75000		18750	17700	15650	12600	9550	6500	4500	2500
Castings											
SA-27	60–30	60000	(8)(9)	15000	14350	12950	10800	8650	6500	4500	2500
SA-27	65–35	65000	(8)(9)	16250	15500	13850	11400	8950	6500	4500	2500
SA-27	70–36	70000	(8)(9)	17500	16600	14750	12000	9250	6500	4500	2500
SA-95		70000	(9)	17500	16600	14750	12000	9250	6500	4500	2500
SA-216	WCA	60000	(9)	15000	14350	12950	10800	8650	6500	4500	2500
SA-216	WCB	70000	(9)	17500	16600	14750	12000	9250	6500	4500	2500

NOTE (4) For service temperatures above 850 F it is recommended that killed steels containing not less than 0.10% residual silicon be used. Killed steels which have been deoxidized with large amounts of aluminum and rimmed steels may have creep and stress rupture properties in the temperature range above 850 F which are somewhat less than those on which the values in the above table are based.

PAR. UG-27(h). In third line, change "18 in." to "30 in."

PAR. UW-51(e)(5). Revise to read:

(5) In each penetrameter there shall be three holes of diameters equal respectively to two, three, and four times the penetrameter thickness, but in no cases less than $^1/_{16}$ in., except that when gamma rays are used as a source of radiation the minimum hole diameter need not be less than $^5/_{32}$ in. The smallest hole must be distinguishable on the radiograph.

PAR. UW-52(b). Revise second sentence to read:

The basic unit design stresses of table UG-23 shall be further reduced by the applicable joint efficiency factor of Table UW-12.

PAR. UG-99(g). Delete and substitute:

Single-wall vessels designed for a vacuum or partial vacuum only, and chambers (of multichamber vessels) designed for a vacuum or partial vacuum only, shall be subjected to an internal hydrostatic test, or where a hydrostatic test is not practicable, to a pneumatic test in accordance with Par. UG-100, except that in all cases the test pressure to be applied shall be not less than $1^1/_2$ times the difference between normal atmospheric pressure and the minimum design internal absolute pressure.

Welding Qualifications 1949

TABLE Q-5, "P" Number 4, "O" Number 1. Delete Specification SA-300.

Material Specifications 1949

EDITORIAL NOTE

The Boiler Code Committee has approved for inclusion in Section II, the ASTM 1950 revisions as they affect SB-111, SB-178, and SB-234 and the addition as a new specification of SB-169-50T. These will be incorporated in the 1951 Addenda to Material Specifications. Meantime those in need of them may secure copies from ASTM.

* Supplies of this new form are now available.

THE ENGINEERING PROFESSION

News and Notes

As Compiled and Edited by A. F. Bochenek

Eleven-Year Time-Study Project Provides Basis for Standard of Fair Day's Work

A BASIS for agreement by labor and management on a standard concept of a fair day's work is now available as the result of an 11-year study on performance ratings recently completed by the Society for the Advancement of Management in co-operation with New York University and 14 industrial organizations.

The study makes available a time-study kit of eight reels of 16-mm black and white motion-picture film and accompanying instruction. It is considered by the sponsors as a landmark in management engineering.

The reels, each containing about 350 ft of film, depict 24 separate industrial, clerical, and laboratory operations. Each operation is performed at five different speeds. In the course of the study these 120 separate operations were viewed and rated by some 1800 engineers in over 200 companies in all sections of the United States. The resulting ratings, some 150,000 in number, were averaged to establish a nationwide standard of performance for manual work.

Official announcement and first public exhibition of the films will take place at the Statler Hotel, New York, N. Y., April 19, 1951, during the SAM-ASME Time and Motion-Study Conference.

The films, according to the sponsors, can be used for the following purposes: (1) To establish a concept of what is a fair day's work; (2) to achieve more uniform time standards among departments of a company; (3) to compare an existing concept of a fair day's work with that prevailing in a large number of companies; and (4) to train engineers, supervisors, and other personnel for greater consistency in judging a fair day's work.

Other secondary uses claimed for the films are: (1) To provide a testing technique that will indicate whether or not an individual has innate ability to judge tempo; (2) to provide a comprehensive procedure for training time-study trainees in rating and for measuring the results of such training; (3) to check time-study observers to determine whether their concept of normal remains correct and whether they retain the ability to evaluate a broad range of observed performances within reasonable limits of accuracy; and (4) to determine whether or not there are regional differences or differences between industries in the concept of standard performance.

While the films are not unique, since a number of private organizations and some universities have developed performance rating films,

THIS SAND-SHOVELING OPERATION IS ONE OF THE 24 BASIC PHYSICAL OPERATIONS FILMED AT FIVE DIFFERENT SPEEDS, WHICH PROVIDES THE BASIS OF THE SAM TIME-MOTION STUDY KITS RECENTLY DEVELOPED AFTER 11 YEARS OF STUDY

the SAM studies are the first that offer a sufficient variety of operations and correlate the judgment of a sufficiently large number of practicing time-study engineers, to provide an acceptable basis for agreement on a national standard.

Studies made with the films in England, Sweden, and Germany indicate that no significant difference exists between the conception of a fair day's work between American and overseas engineers.

How Films Are Used

The films are intended to create a mental concept of normal rates of work against which a time-study observer can compare and judge working rates as being below or above normal. The SAM system rates as 100 per cent the performance of a qualified operator working under incentives at a rate that can be sustained over an eight-hour day, with one hour personal allowance; and 80 per cent as the performance of a qualified dayworker without normal incentive. The practical maximum performance in the films was judged as 140 per cent and the slowest performance at 60 per cent.

The operations used in the study are simple physical operations, such as dealing cards, transporting marbles, shoveling sand, packing cans; stacking cartons, checking tires, and others. All are duplicated many times in most manufacturing organizations. The basic nature of the operations makes it possible for a time-study observer to apply his mental concept of normal rate to similar operations with considerable accuracy.

Herbert A. Lynch, Jr., project engineer, of the SAM project, demonstrated at a preview showing of the films in New York, N. Y., on Feb. 27, 1951, how quickly a mental concept of a rate of work can be acquired through use of the SAM kit.

In a five-minute showing of the films, preceded by brief instruction, most of the editors present were judging ratings within 10 per cent of rates established by the national survey of time-study engineers. The technique of judging was simple. The inexperienced observer had only to imagine himself performing the physical operations at a speed paced by the motion pictures to arrive at an opinion on rating. Extremes of performance were quite obvious. At speeds near normal, it was helpful to ask whether the rate could be worth maintaining for an eight-hour day with or without incentive. The answer was an excellent guide for judging performance in the region of normal rating.

Controversial Issues

The sponsors acknowledge that rating of time studies is the most controversial issue in industrial engineering. Most companies modify stop-watch readings by some method of rating based on judgment. This modification is purely subjective—wholly within the observer's mind. It is made without a physical yardstick against which it can be checked. An observer has only a mental concept as a guide to what is right.

The purpose of the SAM kit is to provide a basis for a standard concept of what is right that will be acceptable to all.

The survey revealed many interesting facts about the rating process. One of the most important was that although various rating scales are used in American industry, there is excellent agreement among time-study observers on what constitutes a fair day's work. Another fact was that personal, fatigue, and general delay allowances affect the rating scale and must be known in advance by time-study observers before they can accurately time and rate an operation. The survey also confirmed findings of other investigators who reported a tendency to overrate poor performances and to underrate good ones.

Harold Engstrom, manager, industrial engineering department, Sylvania Electric Products Inc., who has used the SAM kit to

check rating ability of various engineers, reported that the great variety of work activities in the films, "gives the industrial observer the opportunity to study the various skills and techniques not necessarily related to his own work. By so doing, it creates a better understanding and appreciation of industrial problems as a whole."

SAM Project Committee

The SAM Committee in charge of the project is: Ralph M. Barnes, Mem. ASME, professor, University of California, Los Angeles; Phil Carroll, Fellow ASME, professional engineer; J. M. Juran, Mem. ASME, professor, New York University; J. K. Louden, Mem. ASME, (chairman), vice-president, York Corporation; H. B. Maynard, Mem. ASME, president, Methods Engineering Council; William R. Mullee, Jun. ASME, professor, New York University; David B. Porter, Mem. ASME, (project director), professor, New York University; Ralph Presgrave, Assoc. ASME, vice-president, J. D. Woods and Gordon, Ltd.; G. J. Stegemerten, general manager, Methods Engineering Council. Herbert A. Lynch, Jr., New York University, was project engineer.

Sponsoring Companies

The industrial sponsors who contributed to the $80,000 project are: American Viscose Corporation, Armstrong Cork Company, Atlantic Refining Company, Eastman Kodak Company, Eli Lilly and Company, General Foods Corporation, General Motors Corporation, Owens-Corning Fiberglas Corporation, Procter and Gamble Company, Sylvania Electric Products, Inc., Wagner Electric Corporation, Western Electric Company, Westinghouse Electric Corporation, Worthington Pump and Machinery Corporation.

The rating kits may be obtained from SAM, 84 William Street, New York 30, N. Y. Cost per kit, consisting of films and instruction manual, is $495 to industrial organizations and $375 to engineering schools.

What Is Engineering?

ENGINEERING is essentially a problem-solving occupation. That fact colors the thinking of every engineer. For the research engineer, the problems are to discover and apply natural law. The design engineer solves problems in the economic use of materials. The engineer in plant operation solves problems of quality control, obsolescence, raw-material supply, and trouble-shooting of all kinds. The construction engineer faces complex problems in logistics and in adapting plans and specifications to the unforeseen exigencies of the field. Engineers solve all these problems by rigorous calculation, by past experience, or by plain common sense, depending upon the circumstances. But the main point is, the engineer's life is one long series of problems to be solved, and his success depends on promptly delivering good workable answers. This problem-solving attitude is perhaps the most characteristic feature of engineers as a group. (From "Values Inherent in Engineering," by J. R. Van Pelt, Battelle Memorial Institute, Columbus, Ohio, December, 1950, *The Journal of Engineering Education.*)

Extensive Research Program Sponsored by ASHVE

THE American Society of Heating and Ventilating Engineers is one of the few professional engineering organizations which maintains and operates its own research laboratory. Since 1942 the ASHVE has increased the annual dollar volume of its research expenditures from $32,000 to $160,000 in 1950 when 35 research projects were carried on. During this period the research staff was increased from five to 25 to cope with the accelerated program.

Financial support for the ASHVE research program comes from allocation of 40 per cent of annual membership dues and contributions from industry. The society, founded in 1894, now numbers well over 8000 members and includes engineers, educators, scientists, physicians, architects, contractors, and leaders of industry. Expenditures by the Committee on Research, since the laboratory was founded in 1919, total over $1,500,000. The budget for 1951 is nearly $200,000.

The ASHVE research program is devoted to the determination of the principles and laws underlying all matters in the science of heating, ventilating, and air conditioning. Administration of the program is the responsibility of 19 technical advisory committees. These committees act in an advisory capacity to the Committee on Research and the director of research projects. In addition to reviewing all existing work in its field, each technical advisory committee prepares technical bibliographies and outlines the scope of specific projects. A member of the Committee on Research serves on each technical advisory committee.

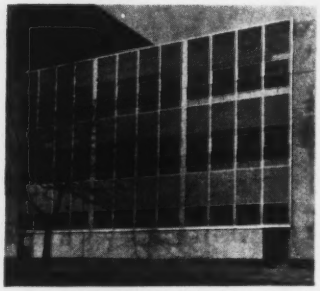
Currently the ASHVE laboratory is working on 22 projects in the following fields: Solar-heat gain and shading effects, panel heating and cooling, air distribution, air cleaning, odors, cooling load, heating load, and absorbents.

In addition, eight co-operative projects are under way at engineering schools and two others are being carried on by ASHVE sponsored fellowships. Co-operating engineering schools are: Case Institute of Technology, Kansas State College, Michigan State College, Cornell University, Columbia University, University of Minnesota, University of Florida, University of Illinois, College of Medicine.

Radioisotope Service Announced

THE U. S. Atomic Energy Commission recently authorized Brookhaven National Laboratory, Upton, N. Y., to make available for distribution certain radioisotopes produced in its new nuclear reactor.

In a joint statement, Wilbur E. Kelley, manager of the AEC's New York Operations Office, and Dr. Leland J. Haworth, director of Brookhaven National Laboratory, said that Brookhaven would supply radioisotopes with very short half-lives, or of higher specific activity (radiation emitted per unit mass) than could be produced in the Oak Ridge National Laboratory reactor. The Oak Ridge reactor will continue to be the nation's principal radioisotopes source.



NEW ALUMNI SCIENTIFIC LABORATORIES BUILDING OF DREXEL INSTITUTE OF TECHNOLOGY, PHILADELPHIA, PA.

(The structure adds 45,000 feet laboratory floor space to the Institute's facilities. The Institute has 2200 day students and 1300 engineering evening students.)

They also pointed to the special irradiation equipment built into the Brookhaven reactor and said that its higher neutron flux (number of neutrons per square centimeter per second) would allow the production of considerably more potent radioisotopes than could be made in the Oak Ridge reactor. The amount of time during which materials must remain in the reactor will also be considerably less at Brookhaven.

Requests for radioisotopes must still be made directly to the Isotopes Division, U. S. Atomic Energy Commission, Oak Ridge, Tenn. Service irradiations will not be performed at Brookhaven unless authorized by the Isotopes Division.

Brookhaven production will be principally concerned with requests for highly radioactive isotopes, isotopes with half-lives too short for distance shipment, or when geographic location or unusual delivery schedules warrant special consideration. Inquiries will be handled at Brookhaven by the Laboratory's Isotopes and Special Materials Group, under the supervision of Dr. Marvin Fox, assistant chairman of the Reactor Science and Engineering Department.

The Brookhaven reactor, which began operation in August, 1950, accommodates a larger number of simultaneous experiments than are possible with any other known reactor. Pneumatic tubes can whisk samples into the reactor and deliver resultant radioisotopes to adjacent laboratories within a few seconds. A conveyer chain of 300 aluminum containers can move samples to be irradiated into the reactor to specified locations where the desired neutron concentration is available. The chain can discharge samples at any time, without disrupting operation of the reactor.

Brookhaven National Laboratory is the northeastern center for nuclear research and development operated by Associated Universities, Inc., under contract with the Commission.

St. Pat's Nearing Half Century of Observance by Engineers

LAST month engineering students on many campuses laid aside their books to honor St. Patrick, patron saint of engineers. They organized parades, attended exhibits, smokers, parties, elected queens, kissed the Blarney Stone, entered the knighthood of St. Patrick, and generally spent a week of good fun.

St. Pat's celebration, however, does not exhibit a uniform pattern across the country. Many engineering students, in fact, have become engineers without knowing the exhilaration of the St. Pat's experience or the sobriety of its aftermath. The tradition is strong in the Midwest, particularly at the University of Missouri, Missouri School of Mines and Metallurgy, and the University of Oklahoma, where St. Pat's is observed as the social high light of the academic year.

Further north at the University of Minnesota where March weather is not too kind, the spirit of St. Pat is held under wraps until a week in May when engineering students relax and celebrate. Engineering schools in the East seem to be indifferent to St. Pat's contribution to engineering education. Some eastern schools hold dances on March 17 but the St. Pat's spirit does not express itself in parades, floats, and competitions.

The idea of a mid-March holiday for engineers is generally considered a good one and many feel that eventually even New York City's Fifth Avenue St. Patrick's Day parade will take on an unmistakable collegiate flavor.

Origins of St. Pat's

The origin of St. Pat's as an engineering event goes back almost 50 years. According to one version, St. Pat's was conceived at the University of Missouri on March 16, 1902, when a group of mechanical-engineering students, under the spell of a hot and lazy spring day, decided to cut classes on the following day, which was St. Patrick's Day. To justify the escapade they cooked up the tale that St. Patrick was an engineer and that engineering students ought to honor him on his name day.

According to plan, the group, which included the late Prof. Walter Rautenstrauch of Columbia University, instead of attending classes, engaged in "various sorts of devilment" in an unorganized fashion in full view from classroom windows and induced other students to cut classes. Later the group persuaded their girl friends to take the day off for an excursion into the spring countryside.

Early spring and the need for a mid-March holiday to break the long stretch of studies from January to June have contributed to establishing St. Pat's celebration as one of the Missouri traditions.

At the University of Minnesota, tradition has it that in 1903 the St. Pat's celebration started when a stone was found on the campus with the inscription "Erin Go Bragh." This was "loosely" translated as "St. Patrick was a mechanical engineer." The event was celebrated on St. Patrick's day until 1938 when it was decided to postpone festivities until sometime in May when mood and weather would be more harmonious.

A Typical St. Pat's Program

A typical St. Pat's tradition was the program of the 37th annual St. Pat's celebration conducted last month at the University of Oklahoma. A week before St. Pat's, engineering students selected four or five campus co-eds as contestants for queen of the engineers. Following the election of the queen, the students chose a captain of the guard, whose main duty was to protect the queen until her coronation at the engineers' dance. An outstanding student was also selected to impersonate St. Patrick. His main duty was to crown the queen.

As the week began, engineering students put on green shirts and the campus newspaper was issued on green paper. The opening social event was the engineers' show which consisted of original dramatic skits written and produced by the various fraternities. Income from the show was used to finance the celebration.

The following day some 800 engineers with their dates attended the annual St. Pat's dance. A large model of a drafting compass was used as an entrance decoration and the walls of the hall were decorated with plaques representing 13 professional engineering organizations. Before the night was out the engineering students witnessed the crowning of their queen. The celebration was concluded with the banquet held in honor of the queen and St. Patrick.

During the evening two honors were bestowed. Keys were given to seniors who have worked on the school's engineering magazine and outstanding students were dubbed Knights of St. Patrick in a colorful ceremony.

Design Professions Draft New Rules for Interprofessional Collaboration

A NEW set of rules for governing relations among construction designers has been proposed in a report on interprofessional collaboration prepared by a joint committee of the American Institute of Architects, American Institute of Electrical Engineers, American Institute of Planners, American Society of Civil Engineers, American Society of Landscape Architects, and The American Society of Mechanical Engineers.

The new rules aim to provide better design for housing projects, airfields, hospitals, and other large-scale projects by releasing creative energies now wasted when the right specialist does not get into the job at the proper time to make his full contribution, or when empty controversy disturbs good working conditions.

Report Before ASME for Approval

The document comprises a general statement of the principles of collaboration among the design professions and a series of outlines spelling out who does what on building projects of various types. The report is now before the ASME and other co-operating organizations for approval. In its final form it will be printed and made generally available to designers.

S. Logan Kerr, consulting engineer, Philadelphia, Pa., is ASME representative on the Joint Committee of the Design Professions which prepared a draft of the new rules. Roy F. Larsen, of the American Institute of Architects, is chairman. Other members are A. F. Brinckerhoff, American Society of Landscape Architects; Joseph H. Ehlers, American Society of Civil Engineers; and Frederick P. Clark, American Institute of Planners.

One of the things the drafting group discovered was that putting together the work of several designers was a job all by itself. They pointed out that "the center of gravity" on a complex building-design job would usually determine which of several design professions had the co-ordinating responsibility, but advised that clients would sometimes get better results if this task were given the designer most experienced in co-ordination, even if his share in a particular undertaking was not the largest.

Collaboration to Benefit Client

Collaboration among specialists within such professions as architecture and engineering has been for years in need of clarification, but this is the first authoritative attempt to organize comprehensively work upon which several professions may be engaged. It has been found that when collaboration has worked well in the past, it has benefited the client. The committee traced the problem to complex building jobs and to educational specialization.

To succeed fully, all designers who collaborate must work together from the beginning, and their working relations should be close and continuous, the report advises. A productive weaving together of interests that will be expressed in the final design demands mutual understandings and agreements that can be made only by principals. Consequently, the responsibility for collaboration cannot be handled by subordinate employees.

Government Jobs

CIVILIAN position vacancies for mechanical engineers and other technical personnel at the Army Engineer Research and Development Laboratories have been created by the stepped-up national defense program. The positions carry salaries up to $6400.

Located on the Potomac River some 20 miles below Washington, D. C., the Engineer Research and Development Laboratories contain some of the finest research, development, and testing facilities in the country.

The requirement is urgent for qualified personnel in our accelerated development programs. For more information, write to: Commanding Officer, Engineer Research and Development Laboratories, Fort Belvoir, Va.

M.I.T. to Offer Special Lubrication Courses

NEW developments in three phases of mechanical engineering will be reviewed in special courses in lubrication engineering, metal cutting, and hydraulic power control designed particularly for engineers in industry by the Massachusetts Institute of Technology. Courses will be given during June and July, 1951.

According to Walter H. Gale, director, M.I.T. summer session, the purpose of the courses is to bring the latest information from research and industrial practice to an audience who cannot participate in regular academic activities.

The lubrication-engineering course, June 11–22, will cover basic and special information needed by a lubrication engineer to meet his responsibility in an industrial plant.

The metal-cutting course, June 25–July 6, will present a unified picture of the metal-cutting process based on recently developed fundamental principles.

The hydraulic power control course, July 9–20, will place special emphasis on recent developments which make possible greater accuracies and speeds of response.

For further information, write to Prof. Walter H. Gale, Room 3–107, Massachusetts Institute of Technology, Cambridge 39, Mass.

Government Policy on Basic Research Announced

A NEW policy formula to guide the Departments of the Army, Navy, and Air Force in their support of basic research was announced recently by William Webster, chairman, Research and Development Board of the Department of Defense.

Under this policy the Department of Defense recognizes the necessity for the support of basic research in the military program and establishes a minimum budget below which this support shall not fall. This budget shall be a fixed percentage of each military Department's average annual total research and development budget for the last five fiscal years.

Stated in round figures, the RDB's new formula provides that the total Department of Defense expenditure for basic research must be at least $30,000,000 in the fiscal year.

The policy will be in effect for three years, and will then be reviewed by the board.

Commenting upon the announced policy, Mr. Webster stated:

"Announcement of the approved RDB policy resolves a problem which has long confronted the military departments. The departments are primarily consumers of end items, such as tanks, radar sets, bazookas. These items are the fruit of applied research. The scientist . . . is not primarily interested in the immediate practical application of what he discovers. However, a military department may quite properly be interested in supporting such research due to realization of its usefulness in applications. Moreover, it may take a period of several years before basic research data become exploited in the design of a new end item.

"Despite these factors, it has long been agreed that the military departments should devote some portion of their budgets to basic research studies," Dr. Webster said. "Basic research is fundamental to the applied research and development which supports the creation of end items. Furthermore, it is essential that outstanding research discoveries and information be made directly available to the Department of Defense, in order to cut down the lag between a scientific discovery and its military application. Conduct of a certain amount of basic research by the military departments is the best means of minimizing this lag."

Metallurgical Advisory Board Is Organized

A METALLURGICAL Advisory Board composed of leading industrial and academic metallurgists was organized recently by the National Research Council of the National Academy of Sciences to advise the Research and Development Board of the Department of Defense on research aspects of some of the nation's most critical metals problems.

Within the limits of specific problem assignments, the metallurgists are to advise the RDB on metals research and development programs conducted or sponsored by the military Services.

Among the metals in critically short supply listed tentatively for the study of the Metallurgical Advisory Board are columbium, tantalum, cobalt, titanium, molybdenum, tungsten, and beryllium. Other metals are, however, expected to be added to this list as the Board progresses in its preliminary studies.

A permanent secretariat and special project committees are to assist the Metallurgical Advisory Board, which also will have the cooperation of the military services, the Munitions Board, and other Federal agencies actively interested in metallurgical problems. Robert F. Mehl, head of the department of metallurgy, Carnegie Institute of Technology, is chairman of the Advisory Board and presided at the first meeting.

ASME groups concerned primarily with metals may be called upon to contribute to the work of the Advisory Board. The American Society of Mechanical Engineers is one of the member bodies of the National Research Council.

France's Oldest Engineering School

THE oldest engineering school in France, L'Ecole Centrale des Arts et Manufactures, is still the principal school for training French engineers in all branches of the profession, according to the January, 1951, issue of *The Engineering Journal*. It was organized in 1829 when French industry began to emerge. Out of the 24 courses provided at the beginning, 22 are still in existence, though they have been adapted to the development of industry and progress of science.

A private school originally, it taught pure applied science, but its students were soon to be an essential part of modern society. In 1857 the School was passed over to the state.

Famous Alumni

Bousquet, a former student, was the inventor of the bogies used under railway carriages. Sautter built more than 2000 lighthouses. Darblay substituted wood pulp for rag in the manufacture of paper.

Eiffel built bridges and that famous tower for the 1889 Exhibition. Berges and Fredet harnessed the first waterfalls and water power. Boivin discovered sugar refining with hydrocarbonate of lime. All these were "centralites."

The School system is a hard one; the course of study is three years and the final diploma carries with it the title of "Ingénieur des Arts et Manufactures." Every year 230 new students enter school after a very stiff competitive entrance examination and go to lectures in the morning, and in the afternoon do practical work. The students have to be present regularly at 8:15 a.m. every day and "clock in" as in factories. What is more they must never "skip" lectures or the amphitheatre!

Specialized Facilities

Laboratories of industrial chemistry and mineralogy; thermic and electrotechnic machines; machine tools and hydraulic workshops; metal and material resistance; radioactivity and reinforced concrete; waves and television—such are the forms of specialization open to the future engineer at the "Centrale." Thus there is nothing to prevent the student who has graduated as an erecting engineer or metallurgist from becoming a chemist, but the tendency is for increasingly greater specialization for engineers.

U. S. Point Four Aid for Israel

THE Technical Cooperation Administration announced recently that the United States and Israel had signed a Point Four agreement calling for United States assistance in training Israeli technicians.

The agreement provides for setting up specific projects in the future under the Act for International Development enacted by Congress last summer.

Israel has already suggested that United States experts would be useful in connection with road construction, railways, irrigation methods, organization of public-health services, technical training, and citrus fruit production.

At the same time Israel would like to send some of its people to the United States for training in deep-sea fishing, the ceramic industry, and ship repairing.

"All of these projects are related to the broad program of economic development projected in Israel's four-year plan and are designed to aid Israel's efforts to develop its resources and improve working and living conditions," said the announcement.

First U. S. National Congress of Applied Mechanics to Be Held in June

The First U. S. National Congress of Applied Mechanics will be held at the University of Illinois, Chicago, Ill., June 11–16, 1951, under sponsorship of the U. S. National Committee on Theoretical and Applied Mechanics.

The purpose of the Congress venture is to bring together all groups interested in applied mechanics for discussion and exchange of information. There is no thought of competing in any way with related activities of separate groups or with the traditionally established international congresses. It is felt that coordination and pooling of the mechanics activities which would normally occur throughout the United States around the time set for the Congress will result in an even greater interest in mechanics, which will be of lasting benefit to all of the societies. International congresses of applied mechanics are held every four years; the 1952 session will be at Istanbul. National congresses will also be held approximately every four years, but never during the same year as an international congress.

The U. S. National Committee was organized following a suggestion to the Applied Mechanics Division of The American Society of Mechanical Engineers, from Martin Goland, Midwest Research Institute, Kansas City, Mo., and N. W. Newmark of the University of Illinois, Urbana, Ill., that applied mechanics workers in the United States ought to meet occasionally at a national congress.

The National Committee

Organizations represented on the U. S. National Committee are: the American Society of Civil Engineers, The American Society of Mechanical Engineers, The American Institute of Chemical Engineers, American Mathematical Society, American Physical Society, The Institute of the Aeronautical Sciences, and the Society for Experimental Stress Analysis. In addition to the U. S. National Committee, an active interest in the Congress has been taken by Illinois Institute of Technology, the Mechanics Division of the American Society for Engineering Education, the University of Illinois, Purdue University, Northwestern University, and the University of Michigan.

Research papers in the various branches of applied mechanics—kinematics, dynamics, vibrations, waves; mechanical properties of materials and failure; stress analysis, elasticity, plasticity; fluid mechanics; thermodynamics—will be grouped by subject and presented at morning and afternoon sessions during the week. These papers are limited to 5000 words or their equivalent in equations, tables, and diagrams in length, and will later be published in full in bound and printed Proceedings of the Congress provided the full manuscript in each case has been favorably reviewed by recognized experts in the respective field of interest. Complete papers or representative abstracts must be submitted to the chairman of the Editorial Committee—Eli Sternberg, Illinois Institute of Technology, Chicago 16, Ill.—before April 15, 1951.

Special Lectures Planned

In addition to the research papers, four or five invited lectures of general interest to those attending the Congress will be presented by outstanding authorities. So far lectures have been scheduled by E. Orowan, whose subject is "Creep in Metals and Polymers," while Richard von Mises and Theodore von Kármán have promised lectures on subjects of aerodynamics.

An afternoon at Northwestern University, which celebrates its 100th birthday in 1951, is planned for Wednesday, June 13. Members of the Congress will enjoy the bus ride along Chicago's beautiful north shore to Evanston where one of the general lectures will be given on the Northwestern campus, and where entertainment is planned. Throughout the week there will be a number of social events, including a reception on Monday and a banquet on Thursday, which will give ample opportunity for informal discussion.

1951 Heat Transfer and Fluid Mechanics Institute

Stanford University, June 20–22

THE fourth annual meeting of the Heat Transfer and Fluid Mechanics Institute is to be held at Stanford University on June 20–22, 1951. The Institute was organized for the purpose of establishing a meeting of breadth and quality which would make a definite contribution to the scientific advancement and intellectual growth of the Western community. Previous meetings of the Institute have been held in California to reduce the effect of geographical isolation of engineers and scientists in the West Coast area, and to provide an opportunity for these men to keep in touch with the latest advances in the fields of heat transfer, fluid mechanics, and related fields. It is, however, the intention of the Institute to maintain participation on a nationwide basis. The first three meetings have had an excellent representation, both in audience and speakers, from research and development centers throughout the country.

Institute sponsors are: California Institute of Technology, Stanford University, University of California, University of Santa Clara, University of Southern California, and the Applied Mechanics, Gas Turbine Power, Heat Transfer, and Hydraulic Divisions of The American Society of Mechanical Engineers.

The Institute will give consideration to problems in thermal radiation, conduction, convection, mass transfer and combustion, ideal compressible and incompressible flow of gases and liquids, and the various aspects of pipe, channel, and boundary-layer flow.

The program will consist of six sessions of three papers each, or a total of eighteen papers. The final program is not yet ready for publication, but the following titles give an idea of the types of papers to be presented: Mechanics of Liquid Drops, Fluid Mechanics Applied to Aluminum Founding, Eddy Conductivity in Convective Transfer, Diffraction of Water Waves by Breakwaters, and Turbulent Mixing of Coaxial Gas Jets.

All papers will be preprinted in full and complete sets of preprints will be on sale at the Institute at a cost of $4. A limited number of sets of preprints will be available for purchase by mail for $5 immediately following the Institute. Preprints will not be available for purchase by mail in advance of the meeting. Papers can be ordered from A. L. London, Department of Mechanical Engineering, Stanford University, Stanford, Calif.

World-Wide Heat-Transfer Discussions Planned for September

THE program for the forthcoming general discussions on heat transmission, to be held in London, Sept. 11–13, 1951, now consists of more than 65 papers of which some 35 are by North American authors, according to the Joint Committee on North American Participation, headed by A. P. Colburn, professor, chemical engineering, University of Delaware, Newark, Del.

MEMORIAL HALL, STANFORD UNIVERSITY, STANFORD, CALIF., WHERE THE 1951 HEAT TRANSFER AND FLUID MECHANICS INSTITUTE WILL TAKE PLACE, HAS A SEATING CAPACITY OF 1739 PERSONS

The Joint Committee consists of representatives from The American Mathematical Society, American Institute of Chemical Engineers, American Chemical Society, American Society of Refrigerating Engineers, American Society of Heating and Ventilating Engineers, The American Society of Mechanical Engineers, American Institute of Physics, American Institute of Mining and Metallurgical Engineers, The American Physical Society, Society of Automotive Engineers, The Institute of the Aeronautical Sciences, and The Engineering Institute of Canada.

Arrangements for American participation are being handled by the ASME. Participation by British and European engineers is being coordinated by The Institution of Mechanical Engineers, with the co-operation of 30 British societies and the engineering and technical societies of Australia, India, New Zealand, South Africa, Belgium, Denmark, France, Holland, Norway, Sweden, and Switzerland.

Preliminary plans indicate that the following subjects will be among those discussed at five sessions: Recent information on physical properties of gases and gas mixtures pertinent to their heat-transfer characteristics, measurement problems related to heat transfer, mass transfer and heat transfer, heat transfer by sweat and film cooling, condensation at high-speed flow, heat transfer to liquid metals, analogy method for the solution of conduction problems.

Some 30 American authors have indicated their intention to attend the discussion. The others will present written discussion. The Joint Committee has acted favorably on publication of conference papers and if financial support is forthcoming, papers will be available after the conference.

ASME Boiler Code Committee to Meet in New Orleans

AT THE invitation of the New Orleans Section of The American Society of Mechanical Engineers, the ASME Boiler Code Committee will hold its regular May meeting at the Roosevelt Hotel, New Orleans, La., May 1, 1951. The meeting will be a feature of the 20th general meeting of the National Board of Boiler and Pressure Vessel Inspectors to be held April 29–May 3, 1951. The National Board members will also be guests of the ASME New Orleans Section.

The practice of holding one regular meeting of the Boiler Code Committee away from New York, N. Y., was instituted several years ago to provide the opportunity for engineers in various ASME Regions to observe the committee at work. Such meetings have already been held in Los Angeles, Chicago, Boston, and Atlanta.

The general meeting will open officially on Monday morning, April 30, with a welcome program during which the following will speak: Bernard J. McCloskey, Commissioner of Public Safety, City of New Orleans; Waldemar Nelson, chairman, ASME New Orleans Section; H. B. Oatley, chairman, ASME Boiler Code Committee; James M. Todd, past-president ASME, and many others.

On Monday evening members of the Society will be guests of the National Board at a reception.

ASME members residing near New Orleans are invited to take advantage of the presence of the Boiler Code Committee. All interested engineers are invited to sit in at the meeting.

The remainder of the program will consist of technical papers, round-table discussions, and social events.

The National Board of Boiler and Pressure Vessel Inspectors is composed of chief inspectors of states and municipalities in the United States, and the provinces in the Dominion of Canada. It was organized in 1919 to encourage uniformity in administering the Boiler code and enforcing its rules. The Board has also worked to secure interchangeability between the political subdivisions of the United States and the provinces of Canada.

The ASME Boiler Code has been adopted by 38 states, many municipalities, Hawaii, Puerto Rico, and the Panama Canal Zone, and by all the provinces of Canada. The high regard in which the Code is held by American industry was one of the reasons why the International Organization for Standardization invited the ASME to assume the secretariat of the international boiler-code project.

Utilization of Manpower Theme of SAM-ASME Conference

THE Sixth Annual Time-Study and Methods Conference sponsored by the Society for the Advancement of Management and the Management Division of The American Society of Mechanical Engineers will be held April 19–20, 1951, at the Hotel Statler, New York, N. Y.

A feature of the conference will be the first public showing of films produced by the SAM research project on time studies. It is claimed that the films provide a new tool for more effective management (see page 353 of this issue).

Under the general theme "National Security Through Better Utilization of Manpower Resources," a program of 11 papers has been arranged.

The registration fee for the conference, including two luncheons and dinner, will be $20 for SAM and ASME members and $25 to nonmembers.

The program follows:

THURSDAY, APRIL 19

Morning

Preparation

How to Organize and Operate an Industrial Department, by *W. Gilbert Brooks*, chief industrial engineer, Pitney-Bowes, Inc., Stamford, Conn.

How to Meet the Industrial Engineering Manpower Shortage, by *P. Kay Schwartz*, vice-president, Proctor and Schwartz, Inc., Philadelphia, Pa.

Luncheon Session

Subject: **Selling Industrial Engineering**

Speaker: *H. B. Maynard*, president, Methods Engineering Council, Pittsburgh, Pa.

Afternoon

Improving the Tools

How to Chart Time-Study Data, by *Phil Carroll*, professional engineer, Maplewood, N. J.

Improving Methods Through M.T.M., by *Ralph Kirwin*, chief industrial engineer, Bulldog Electric Products Company, Detroit, Mich.

Improving the Time-Study Rating Process, by *S. M. Dix*, industrial engineer, General Foods Corporation, New York, N. Y.

Dinner Session

Subject: **On Time With Enough**

Speaker to be announced

FRIDAY, APRIL 20

Morning

Better Methods Mean More Manpower

Incentives for Indirect Labor, by *George Diesk*, American Box Board Company, Grand Rapids, Mich.

Measuring Multiple-Machine Interference, by *Dale Jones*, assistant professor, industrial engineering, Georgia Institute of Technology, Atlanta, Ga.

Tailoring the Incentive Plan, by *Paul J. MacCutcheon, Jr.*, chief industrial engineer, Peter Cailler Kohler Swiss Chocolates Company, Fulton, N. Y.

Luncheon Session

Subject: **Measurement—A Tool for Management**

Speaker: *Ralph Presgrave*, vice-president, J. D. Woods & Gordon, Ltd., Toronto, Can.

Afternoon

Let's Work With A Will

Time-Study Training for Supervision, by *J. F. Biggane*, chief industrial engineer, Maytag Company, Newton, Iowa.

Simplifying the Product Design, by *Collier A. Elliott*, director, product and packaging design, Methods Engineering Council, Pittsburgh, Pa.

Layout Planning With Three-Dimensional Models, by *Robert T. Charlton*, production engineer, Magee Carpet Company, Bloomsbury, Pa.

Plastics Industry Ready for Defense Production

GOVERNMENT representatives from the Army, Navy, Air Corps, Quartermaster Corps, Bureau of Ships, National Production Authority, and others, met recently with the Thermosetting Plastics Molders' Committee for National Defense of the Society of the Plastics Industry, Inc., at a luncheon meeting in the Shoreham Hotel, Washington, D. C.

The purpose was to acquaint government representatives interested in the use of plastics in the defense program with the industry's production capabilities. Representatives from plastics companies all over the country attended to present the most recent developments in the industry of significance to the defense program.

Of the 385 companies engaged in the thermosetting molding of plastics products, 99 per cent have fewer than 500 employees and 78 per cent, or 291 companies, have less than 200 employees. However, production output is very large in relation to the number of workers, due to the fact that the thermosetting molding process is highly mechanized and finishing operations are held to a minimum.

During the years 1939 through 1945, this industry registered approximately a threefold expansion in its output, the number of compression-molding presses growing from 3250 in 1939 to 12,000 in 1945. Since then, increased press sizes, the use of electronically preheated plastic materials, and improved molding tech-

niques place this branch of the plastics industry in an even better position to produce large quantities of war and essential civilian plastics products.

Government representatives were told that because of the development of new molding materials which flow more freely and set up in a fraction of the time formerly required, the plastics industry is able to produce products many times faster and several times larger than anything produced five years ago. The 35-pound television cabinet which the industry has been producing in volume over the past year opens new possibilities for defense applications, it was said.

Use of reinforcing materials such as fibrous glass promises the possibility of producing products with strength characteristics in excess of any other material on a weight basis. Among the defense products which the plastics industry can produce in quantity are bayonet grips, buttons, bomb releases, compass mountings, rocket parts, tube sockets, and scores of others, government representatives were told.

Notes on Coming Meetings

Packaging

PACKAGING requirements of the Armed Forces will be explained to industry by representatives of the Army, Navy, and the Air Force at the American Management Association's three-day National Packaging Conference, April 17–19, at the Auditorium, Atlantic City, N. J. The conference will be held in conjunction with the 20th annual AMA National Packaging Exposition.

Materials Handling

THOUSANDS of new models of handling machines of more than 200 companies will be on display in a 10-acre exhibit space, six indoors, and four outdoors, during the National Materials Handling Exposition to be held in the International Amphitheatre, Chicago, Ill., April 30–May 4, 1951.

The Exposition will be held concurrently with the Conference on Materials Handling sponsored by the American Material Handling Society during which 58 experts on materials handling will discuss new handling techniques. Rear-Admiral M. L. Ring, U. S. Navy, director of supply management, Munitions Board, will discuss "The Military Importance of Materials Handling."

Anthracite

THE Annual Anthracite Conference of Lehigh University, Bethlehem, Pa., will be held May 4–9, 1951. The conference usually attracts 300 or 400 men working in all subdivisions of the anthracite industry to discuss new ideas for uses of anthracite and to hear reports of progress on better methods of burning anthracite as a domestic and industrial fuel. For the program, write to A. C. Callen, Lehigh University, Bethlehem, Pa.

British Industries Fair

THE British Industries Fair, Britain's annual industrial show, will be held from April 30 through May 11, 1951. Heavy industry will be centered in Birmingham, England, and other trades will be on show in London in the biggest display in the Fair's 35-year history. Stand space will occupy more than a million square feet and over 90 industries will be represented by the 3000 exhibitors.

Canadian Trade Fair

CANADIAN high-speed woodworking machines, Swiss textile machinery, British machine tools, and a wide range of other industrial products and materials will be on display during the 1951 Canadian International Trade Fair to be held at the Exhibition Grounds, Toronto, Ont., Can., May 28–June 8, 1951. The Fair precedes the 1951 Semi-Annual Meeting of The American Society of Mechanical Engineers to be held in Toronto, June 11–16, 1951.

Festival of Britain

A JOINT engineering conference will be sponsored by The Institution of Civil Engineers, The Institution of Mechanical Engineers, and The Institution of Electrical Engineers as part of the Festival of Britain. The conference will be held in London, June 4–15, 1951. Its objective will be to record the contributions to the advancement of civilization made by British engineers and scientists. Distinguished foreign engineers are being invited to discuss developments in their own countries.

World Chemical Conclave

THE World Chemical Conclave will be held in New York, N. Y., and Washington, D. C., Sept. 3–16, 1951, in connection with the Diamond Jubilee of the American Chemical Society. More chemists and chemical engineers from all parts of the world are expected to be in the United States during that period than ever before. The International Union of Pure and Applied Chemistry will hold its 16th conference in New York and will sponsor the 12th International Congress of Pure and Applied Chemistry as part of the ACS Diamond Jubilee celebrations.

Aviation

THE Third International Conference sponsored jointly by the Institute of the Aeronautical Sciences and The Royal Aeronautical Society of Great Britain, will be held in Brighton, England, Sept. 3–14, 1951. The technical program will consist of 10 British and 10 American papers.

Some of the topics covered by the British papers will be: Influence of Size on Performance of Jet Engines, by S. J. Moyes and W. A. Pennington, National Gas Turbine Establishment; A Survey of Aerodynamic Advances, by A. Fage, The National Physical Laboratory; and Material Properties for High-Altitude Operation, by T. P. Hughes, Royal Aircraft Establishment.

The American papers will cover such subjects as: Structural Problems of Future Aircraft, by Nicholas J. Hoff, Polytechnic Institute of Brooklyn; Transonic Aerodynamics, by John Stack, Langley Aeronautical Laboratory, N.A.C.A.; Jet and Rocket Propulsion, by L. Dunn, California Institute of Technology.

For further information, write to Robert R. Dexter, Secretary, IAS, 2 East 64th Street, New York 21, N.Y.

IEC 50th Anniversary

THE International Electrotechnical Commission has accepted the invitation of the U. S. National Committee of the IEC to hold meetings in the United States in 1954. These meetings will be in celebration of the Fiftieth Anniversary Jubilee of the IEC.

Preliminary planning for the meeting is under way. While plans are not yet final, it seems probable that the meetings will take place during the first two weeks of September, 1954, and will be held within 250 miles of New York.

Meetings of Other Societies

April 16–18
Society of Automotive Engineers, aeronautic meeting and aircraft-engineering display, Statler Hotel, New York, N. Y.

April 16–18
American Society of Lubrication Engineers, annual convention and lubrication show, Bellevue-Stratford Hotel, Philadelphia, Pa.

April 17–20
American Management Association, 20th national packaging exposition, Atlantic City Auditorium, Atlantic City, N. J.

April 19–20
Society for the Advancement of Management, time-study and methods conference, Statler Hotel, New York, N. Y.

April 23–25
National Academy of Sciences, annual meeting, Washington Hotel, Washington, D. C.

April 23–26
American Foundrymen's Society, 55th annual convention, Buffalo, N. Y.

April 29–May 4
American Water Works Association, annual meeting, Miami, Fla.

April 30–May 1
Association of Iron and Steel Engineers, spring meeting, Statler Hotel, Detroit, Mich.

April 30–May 3
American Petroleum Institute, 16th midyear meeting, Mayo Hotel, Tulsa, Okla.

May 7–11
National Fire Protection Association, annual meeting, Statler Hotel, Detroit, Mich.

May 7–11
Forest Products Research Society, annual meeting and international industry show, Convention Hall, Philadelphia, Pa.

May 9–11
The Engineering Institute of Canada, annual meeting, Mount Royal Hotel, Montreal, Can.

May 10–12
New York State Society of Professional Engineers, 25th annual convention, Hotel Statler, New York, N. Y.

(For ASME Calendar of Coming Events see page 365)

Wood Industry

THE Forest Products Research Society will hold its Fifth Annual Meeting at the Convention Hall, Philadelphia, Pa., May 7–13, 1951. Ten technical sessions are planned under the theme "Wood Mobilization Requirements and Developments in Machines, Products and Processes." A feature of the meeting will be the International Industry Show which will exhibit products and woodworking machinery of interest to the wood industry.

Radioisotopes

A CONFERENCE on the use of radioisotopes in industry will be held at Iowa State College, Ames, Iowa, May 1–3, 1951. The conference will consider nature of radioactivity, availability of isotopes, equipment required, and design of laboratories.

For further information, write to Dr. Glenn Murphy, Iowa State College, Ames, Iowa.

Engineering Literature

Pressure Piping

A REVISION of the 1942 issue of American Standard Code for Pressure Piping including supplements 1 and 2, was recently published by The American Society of Mechanical Engineers. The new edition takes into account new materials and designs developed to meet the increased severity of service encountered in industry

The 101-page code presents minimum safety requirements for (1) selection of suitable materials, (2) dimensional standards for elements of piping systems, (3) design of component parts as well as assembled units including necessary supports, (4) erection of systems, and (5) tests of elements before erection and completed systems after erection.

The standard is intended to serve as a guide for those who design, manufacture, and erect piping systems.

More than 30 engineering societies, government bureaus, trade associations, and institutions were represented on the Sectional Committee responsible for the revision.

A copy of Section 9, Standard Qualifications for Welding Procedure and Welding Operators of the ASME Boiler Construction Code, is included in a cover pocket of the revised standard.

Copies may be obtained from ASME Order Department, 29 West 39th Street, New York, N. Y. Price per copy is $3.50.

ASME Boiler Code Addenda

THE 1950 addenda to Section II, Materials Specifications, of the ASME Boiler Construction Code are available to users of the Code. The addenda cover more than 220 pages and contain reprints of 12 specifications which were extensively revised and four new specifications. Copies may be obtained from ASME Order Department, 29 West 39th Street. New York, N. Y. Price per copy is $2.

People

ASME Elects Two New Fellows

HALVOR O. HEM, consulting engineer, Toledo, Ohio, and Ralph C. Roe, consulting engineer, president, Burns and Roe, Inc., New York, N. Y., were recently elected Fellows of The American Society of Mechanical Engineers.

To be qualified as a nominee to the grade of Fellow one must be an engineer who has acknowledged engineering attainment, 25 years of active practice in the profession of engineering or teaching of engineering in a school of accepted standing, and has been a member of the Society for 13 years. Promotion to the grade of Fellow is made only on nomination by five Fellows or members of Society to the Council to be approved by Council.

Halvor Olsen Hem

Dr. Hem was born in Saude, Norway, Aug. 13, 1863, and came to the United States in 1882. As chief engineer and vice-president of H. N. Strait Manufacturing Company, Kansas City, Mo., he developed a line of scales, testing machines, barrelmaking machines, gas and steam engines, and centrifugal pumps.

He went with the Toledo (Ohio) Scale Company in 1915 as consulting engineer in the design of scales and testing machines for use in the automotive and aviation industries. From 1924 to 1947, as chief engineer of that company, he contributed to the development and design of testing machines for balancing propeller blades and a machine for measuring all reaction forces on an actual airplane in a wind tunnel. Since 1947 he has been consulting engineer to Toledo Scale Company, Chrysler Corporation, National Advisory Committee for Aeronautics, and others.

He was awarded the John Wetherill Medal by The Franklin Institute in 1932 and an honorary DS degree by the University of Toledo (Ohio) in 1936. He contributed several technical papers and holds over 100 U. S. patents pertaining to precision devices and as many foreign patents.

Ralph C. Roe

Mr. Roe is credited with many improvements in the power-plant field contributing to high efficiencies. He is one of the pioneers in high-pressure steam engineering, having designed one of the first 1400-psi power plants in the United States. The Roe cycle of regenerative heating was one of his developments. He was also one of the early advocates of centralized control for operation of power plants now being used in the newest power stations.

Mr. Roe was born in Marcellus, N. Y., Dec. 12, 1890. After attending Penn Yan Academy, Penn Yan, N. Y., he began his career in 1910 as an operating engineer with the Marcellus Electric Company. During the next 14 years he worked for several public utilities in positions of increasing responsibility.

In 1926 he took a position with the General Engineering and Management Corporation as engineer responsible for operations of all power plants controlled by that company. In 1929, as a member of the engineering staff of the Electric Management and Engineering Corporation, he was in responsible charge of design of new generating facilities of that system. Since 1935 Mr. Roe has been president of the consulting firm of Burns and Roe, Inc., which has designed or served as consultants for more than 40 steam generating units.

Mr. Roe is a fellow of the American Institute of Electrical Engineers. He is author of many articles in the technical press relating to his work. He holds patents on air-cooling and conditioning systems and on many improvements in steam-power generation, including the Roe cycle.

Brian G. Robbins, New IME Secretary

BRIAN G. ROBBINS was recently appointed secretary of The Institution of Mechanical Engineers (Great Britain). He succeeds Sir Henry Guy, who retired from the secretaryship of the Institution as a result of ill health.

Mr. Robbins was educated on the engineering side of Christ's Hospital, West Horsham, gaining a Clothworker's Scholarship to the City and Guilds (Engineering) College, South Kensington, where he took an ME degree after a short period of service in the Royal Engineers at the end of the first world war. For research work which followed the degree course and led to the Diploma of the Imperial College, he was awarded an Unwin Scholarship. This was followed by four and a half years at Vauxhall Motors, Ltd., Luton, England, where he obtained workshop training and planning-office experience before returning to college for a period of research and teaching.

He joined The Institution of Automobile Engineers as assistant secretary in 1934. He contributed two papers to its Proceedings.

As a result of the amalgamation between IME and the Institution of Automobile Engineers, Mr. Robbins became a member of the IME staff in April, 1947, as an assistant secretary.

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EDWARD A. UEHLING, Mem. ASME since 1883, 101, the oldest living alumnus of Stevens Institute of Technology, a graduate of the class of 1877, was among the recipients of honor awards presented recently by the Stevens Alumni Association at its 81st anniversary dinner. WILBUR H. ARMACOST, Fellow ASME, vice-president in charge of engineering, Combustion Engineering-Superheater, Inc., New York, N. Y., and THOMAS E. MURRAY, Fellow ASME, commissioner of the U. S. Atomic Energy Commission, formerly president of the Metropolitan Engineering Company, Brooklyn, N. Y., were also presented honor awards. ARTHUR G. GLASGOW, Mem. ASME, chairman,

Humphreys and Glasgow, Ltd., London, England, was awarded the alumni award medallion for "outstanding loyalty and devotion to the college." HARVEY N. DAVIS, Hon. Mem. and past-president, ASME, president of Stevens Institute, and guest of honor at the dinner, was presented with the distinguished service award of the Stevens Metropolitan Club.

* * *

JAMES DRAPER FRANCIS, of Huntington, W. Va., chairman of the board of directors, Island Creek Coal Company, Pond Creek Pocahontas Company, and affiliated companies, received the Charles F Rand Medal for 1951 of the American Institute of Mining and Metallurgical Engineers during the annual meeting of the institute held recently in St. Louis, Mo.

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EDWIN HOWARD ARMSTRONG, Holley Medalist, 1940, professor of electrical engineering, Columbia University, New York, N. Y., received the Washington Award for 1951, "for outstanding inventions basic to radio transmission and reception and notable service to his country." The award, which was presented at a dinner held in Chicago, Ill., Feb. 19, 1951, is administered by the Western Society of Engineers on recommendation of a commission representing the Founder Societies and the Western Society of Engineers.

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GEORGE J. NICASTRO, Mem. ASME, sales engineer, Combustion Engineering-Superheater, Inc., New York, N. Y., has been elected vice-president in charge of the Northeastern Region of the National Society of Professional Engineers.

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JAMES M. TODD, past-president and Fellow ASME, consulting engineer, New Orleans, La., was made an Honorary Member of the Louisiana Engineering Society on Jan. 20, 1951. He is a member of long standing and a past-president of LES and has served it for many years.

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RALPH J. KOCHENBURGER, assistant professor of electrical engineering, University of Connecticut, Storrs, Conn., consultant on controls for the M. W. Kellogg Company, Jersey City, N. J., was awarded the Alfred Noble Prize for 1950 for a paper entitled, "A Frequency-Response Method for Analyzing and Synthesizing Contractor Servomechanisms," during the winter general meeting of the American Institute of Electrical Engineers, held at the Hotel Statler, New York, N. Y., Jan. 22-26, 1951. The Noble prize is a joint award of the four Founder Societies and the Western Society of Engineers and consists of a cash award of $350 and a certificate. The award is made annually to a young member of one of the sponsoring societies for a published technical paper of unusual merit.

Mr. Kochenburger, an associate member of the AIEE, has also been awarded the Institute's first prize in the Industrial Division for his outstanding paper.

METROPOLITAN SECTION HONORS RALPH C. ROE, NEW ASME FELLOW

(*Left to right:* E. G. Bailey, past-president, ASME; William H. Bryne, chairman, Metropolitan Section; Mr. Roe, consulting engineer, Burns and Roe, Inc., New York, N. Y.; and Harry Kessler, vice-president ASME Region II. The presentation was made at an informal luncheon at The Engineers' Club attended by many of Mr. Roe's business associates.)

THE Institute of the Aeronautical Sciences conferred seven fellowships and two honorary fellowships upon eight Americans and one Englishman at the Honors Night Dinner in New York, N. Y., Jan. 29, 1951. The honorary American fellow for this year was CAPT. WALTER S. DIEHL, U.S.N., assistant for research liaison, Office of Assistant Chief, Bureau of Aeronautics, Department of the Navy. The honorary foreign fellow was SIR HENRY TIZARD, chairman, Advisory Council on Scientific Policy, Ministry of Defence, England. The newly elected American fellows include: M. B. AMERS, JR., REAR ADM. C. M. BOLSTER, U.S.N., E. F. BURTON, LIEUT. GEN. B. W. CHIDLAW, U.S.A.F., SHERMAN FAIRCHILD, Assoc. ASME, R. L. HALL, and G. S. SCHAIRER.

* * *

ISLYN THOMAS, president, Thomas Manufacturing Corporation, Newark, N. J., was elected national president of the Society of Plastics Engineers for 1951. The other newly elected national officers are: W. O. Bracken, vice-president; W. F. Oelman, secretary; and W. J. Dunnican, treasurer.

* * *

RALPH E. FLANDERS, past-president and Hon. Mem. ASME, U. S. Senator from Vermont, was recently elected honorary member of The Institution of Mechanical Engineers in recognition of his great contributions to the distinction in practice of the organization and administration of engineering.

* * *

CHARLES S. DRAPER, Mem. ASME, professor of aeronautical engineering, director, Instrumentation Laboratory, Massachusetts Institute of Technology, Cambridge, Mass., who developed a computing gunsight for fighter planes, received the Exceptional Service Award, highest civilian decoration in the gift of the Air Force from Thomas K. Finletter, Secretary of the Air Force, in ceremonies at the Institute, Jan. 23, 1951.

* * *

DALE ROEDER, executive engineer, Commercial Vehicles, Ford Motor Company, Dearborn, Mich., took office on Jan. 12, 1951, as president of the Society of Automotive Engineers for 1951.

* * *

J. F. PRITCHARD, Mem. ASME, president, J. F. Pritchard and Company, Kansas City, Mo., was elected president of the National Constructors Association, an organization composed of engineers and builders of chemical plants, steel mills, and petroleum refineries.

Professional Development

A POPULAR subject for discussion before groups of engineering students and young graduate engineers is that of professional development in the postcollege years. Somehow, if you have heard one, you have heard them all. Invariably, they feature in some prominent position, among other things, civic responsibility and engaging in politics on the local level. While this facet of the young engineer's development deserves some remarks, it is overemphasized and presented in very vague terms. Except in rare instances, the young engineer's participation in civic affairs is limited to the act of voting and participating in jury duty. It is difficult for a young engineer to participate in local politics upon moving into a new community.

On the other hand, being active in the professional societies is invariably forgotten by the speaker, or barely mentioned. Certainly attending society meetings, participating in the discussions, and taking active part in committee work will be of real benefit in the development of the young engineer, not to mention strengthening the profession of which he is a member. With such experience in his own societies, the engineer will be better equipped with the necessary poise and articulation to exert influence in his community and take part in civic affairs.

The ASME has recognized its responsibility in providing for such training of young engineers. The existence of junior advisers to the various committees of ASME is one of many evidences of this recognition. Some employers understand this phase of professional development and encourage young engineers to become active in their professional societies.

Unfortunately, too many industrial organizations are willing to reap the benefits of technical organizations and engineers without contributing toward their development.

It is up to the individual engineer to recognize his opportunity and overcome the natural inertia. It is he who stands to gain the most professionally and financially.

The importance of the professional society in the young engineer's development should be brought to the attention of recent graduates more often. This aspect of professional development has too often been neglected or forgotten.

H. G. WENIG, Jun. ASME.

ASME NEWS

Ontario Section to Be Host to ASME During 1951 Semi-Annual Meeting

Headquarters: Royal York Hotel, Toronto, Ontario, June 11–15

THE 1951 Semi-Annual Meeting of The American Society of Mechanical Engineers to be held at the Royal York Hotel, Toronto, Ontario, Canada, June 11–15, 1951, will mark the third time the ASME has accepted an invitation of the ASME Ontario Section to hold a national meeting in Canada. In 1932 a delegation of 150 members and guests held a memorable semi-annual meeting at Bigwin Inn, Lake of Bays, Canada. In 1943 the Society held its Fall Meeting in Toronto.

International Trade Fair

Contributing to the international atmosphere of the meeting will be the Canadian International Trade Fair which will take place in Toronto, May 28–June 8. The Fair is an inducement for members to arrive in Toronto a week prior to the ASME meeting. Some 33 countries will have on exhibit samples of merchandise, divided into 20 different trade classifications. Americans who missed the exciting international trade fair held recently in Chicago will have an opportunity in the space of a few buildings to inspect the products of industrial skills of countries overseas.

Varied Technical Program

The technical program of the meeting will consist of 38 technical sessions, luncheons, dinners, and inspection trips. The Engineering Institute of Canada has been invited to cosponsor several social events and technical sessions. The following Professional Divisions and Committees are sponsoring sessions, Aviation, Fuels, Gas Turbine Power, Heat Transfer, Hydraulic, Industrial Instruments and Regulators, Machine Design, Management, Materials Handling, Metals Engineering, Petroleum, Power, Process Industries, Production Engineering, Railroad, Rubber and Plastics, American Rocket Society, Education Committee, National Junior Committee, and Cutting Fluids.

Toronto, A Thriving Canadian City

In addition to the excellent technical program currently taking shape and the excitement of an international trade fair, another reason to make plans now for attending the Semi-Annual Meeting is the attractions of the city of Toronto itself. Because of its phenomenal growth and its farsighted preparations for the future, Toronto has been described as a "regular riot of self-confidence." In 1946–1947, nearly 50 per cent of all new industrial development in the Dominion of Canada took place within 14 miles of Toronto's City Hall. This development is still under way. The consolidation of interests of existing Canadian companies, the establishment of plants in Canada by British industries, and the multiplication of subsidiaries of the American manufacturing companies continues without abatement.

Within a 100 mile radius of Toronto the "middle third" of the buying power of the Canadian market is situated.

In her expansive moods, Toronto has built thousands of acres of lake-front land, made plans for docking ocean vessels, put a million dollars into a new Canadian National Exhibition building, has laid down sixteen-foot sidewalks on newly widened streets in preparation for future business, and is now building a rapid-transit subway.

FREDERICK TRUMAN, ASSISTANT CHIEF ENGINEER, S. A. ARMSTRONG, LTD., TORONTO ONTARIO, GENERAL CHAIRMAN FOR ASME 1951 SEMI-ANNUAL MEETING

Toronto is not only a manufacturing, industrial, and shipping center but it is a seat of government, a university town, an art and music center, and a resort area.

The Province of Ontario, which is 1000 miles from east to west and 1050 miles from south to north, accounts for 33 per cent of the population, 38 per cent of Canadian income, 39 per cent of retail sales, 48 per cent of manufacturing production, and 43 per cent of the country's buying power. About 45 per cent of Canadian motor vehicles are in Ontario. The Province consumes 58 per cent of the electric energy used in Canadian homes.

As a manufacturing center the city of Toronto is the home of 3800 industries, from acids and alkalies to yarns, and claims the largest concentration and widest diversification of United States and British branch plants of any city in the world.

As a distributing center, it sees an average of 220 freight and passenger trains arrive and depart daily, and 4,000,000 tons of cargo a year pass through the $40,000,000 harbor facilities. By air flight time is less than three hours from its Malton Airport (17 miles or about 25 minutes by car from the downtown area) to New York or Chicago.

For members who like to combine the Semi-Annual Meeting with a vacation, a visit to Toronto offers ample opportunity for all sorts of diversions. The city abounds in parks,

Toronto Tourist Convention, Inc.

VIEW OF TORONTO SKYLINE FROM CENTER ISLAND. THE ASME 1951 SEMI-ANNUAL MEETING WILL BE HELD IN TORONTO, JUNE 11–15

interesting monuments, and a variety of buildings in various styles. Its park system contains over 2000 acres of land divided into recreation.

Committee

The following committee is in charge of arrangements: *General chairman*, F. Truman; *vice-chairman*, H. G. Thompson; *secretary*, W. R. Trusler. The chairmen of the various subcommittees are as follows: *Meetings*, C. R. Davis; *Technical Events*, R. R. Service; *Inspection Trips*, I. W. Smith; *Transportation*, J. D. Bourns; *Registration*, W. G. McIntosh; *Hotels*, R. A.Walker; *Entertainment*, W. D. Sheldon; *Women's Events*, Mrs. H. G. Thompson, F. G. East; *Publicity*, W. E. Mickleth-waite; *Reception*, H. H. Angus; *Printing and Signs*, C. E. Lewis; *Finance*, G. Ross Lord.

Three Noteworthy ASME Meetings Scheduled for Mid-April

THREE meetings of more than usual interest will be sponsored by The American Society of Mechanical Engineers during the second and third weeks of April. These meetings are in widely separated industrial centers and are noteworthy because they make available to members in these centers an opportunity to participate in an ASME program on a scale similar to that of a national Society meeting.

Kansas City

For members in the vicinity of Kansas City, Mo., there will be the annual meeting of Region VIII, at the President Hotel, April 16-18, which offers a program of more than eight papers on a wide variety of technical subjects of interest to Midwestern industry (for program see page 270 of the March issue). Because of the regional nature of this meeting, members will be able to meet Region officers and many of the chairmen of ASME Sections in Region VIII.

Pittsburgh

Members in the Pittsburgh, Pa., area will be able to attend the two-day program of the Pittsburgh Section called the Pittsburgh Mechanical Engineering Conference at the William Penn Hotel, April 19-20. This annual event is supported by five other professional societies which have local sections in Pittsburgh. The two-day program offers papers in heating, mechanical construction, refrigeration, materials handling, metal surfacing, power, lubrication, and metalworking. For details of the program, see pages 270 and 271 of the March issue.

Rooms have been reserved for members planning to attend the Pittsburgh Conference at the William Penn and Pittsburgher Hotels. For reservations, write to K. F. Treschow, Engineers Society of Western Pennsylvania, William Penn Hotel, Pittsburgh 19, Pa.

Baltimore

For members residing in the vicinity of Baltimore, Md., there will be the Process Industries Conference at the Lord Baltimore Hotel, April 17-19, 1951. This program offers 14 technical papers on the general problem of pollution of industrial air and water resources.

This conference is a good example of how the Society serves its members through its professional divisions. This is the second national conference sponsored by the Process Industries Division. Its purpose is to funnel into the literature technical papers on problems confronting engineers in the process industries.

Baltimore members who are interested in such industrial processes as air conditioning, refrigeration, evaporation, drying, sanitation, and others will find much of interest in the detailed technical program which appeared on pages 271-272 of the March issue.

By attendance at ASME meetings and by learning to know the individuals who plan and administer them, members can increase their pleasure and profit from ASME membership.

ASME OGP Division to Meet in Dallas, Texas, June 25–29, 1951

THE Oil and Gas Power Division of The American Society of Mechanical Engineers will hold its 23rd annual conference and exhibit at The Baker Hotel, Dallas, Texas, June 25-29, 1951.

In arranging for conference facilities, the Division was careful to select a hotel that was air-conditioned throughout to insure comfort of the delegates.

This year the Oil and Gas Power lecture series will be held on Tuesday, June 26, as a regular part of the technical program. While the names of the lecturers have not yet been revealed, it is known that the lectures will deal with problems of governing oil and gas engines.

A nominal registration fee will be charged. This will entitle members to receive copies of the conference papers and to attend the special lecture series.

The social high light of the conference will be the banquet on Wednesday. On this occasion the Oil and Gas Power Division will honor authors of outstanding papers presented before the Division in 1950.

Interesting Papers Scheduled

Many interesting papers are scheduled. The technical program of the conference has not yet crystallized but an idea of the subject matter and the diversity of engineering problems to be discussed may be had from the following list of papers already received:

Effect of Charge Temperature and Pressure Upon the Rating of Diesels, by Ralph Miller, chief engineer, Nordberg Manufacturing Company.

Damage Prevention From Diesel-Engine Crankcase Explosions, by Albert C. Cavileer, head of large Diesel engines branch, Internal Combustion Engine Laboratory, U. S. Naval Engineering Experiment Station.

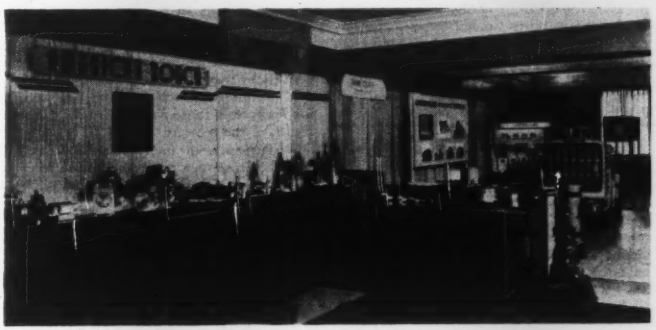
Modern Gas Engines, by Ralph L. Boyer, vice-president, and chief engineer, and W. R. Crooks, resident engineer, Cooper-Bessemer Corporation.

Operation of a Direct-Connected Engine-Driven Compressor as a Gas Generator, by J. N. MacKendrick, vice-president; George Bollman, project engineer; and C. A. Chamberlain, project engineer, Clark Brothers Company, Inc.

Design of Exhaust Snubber for the Gas Engine, by R. L. Leadbetter, vice-president, Burgess-Manning Company.

Performance and Operation of Water-Cooling Equipment, by Howard E. Degler, technical director, The Marley Company.

A feature of the program will be a panel discussion on "Gas-Engine Maintenance." Two sessions of the panel are scheduled. In the morning session, gas-engine maintenance will be explored from the point of view of operators. In the afternoon session, manufacturers representatives will take a look at the same subject.



SOME 30 MANUFACTURERS OF DIESEL ENGINES AND AUXILIARIES ARE PLANNING TO EXHIBIT THEIR PRODUCTS DURING THE 1951 OIL AND GAS POWER CONFERENCE TO BE HELD AT THE BAKER HOTEL, DALLAS, TEXAS, JUNE 25–29

Diesel Exhibits

Every year the Oil and Gas Power Division arranges with selected manufacturers to display their products which are of interest to members of the Division. Year after year these exhibits have increased the benefit and pleasure to be derived from attendance. This year some 30 exhibitors will be represented. At this exhibit members can expect to learn what is new in the way of Diesel engines and auxiliaries.

Friday of the conference is being set aside for a 12-hour field trip to two widely scattered Texas industrial plants utilizing internal combustion using Diesel engines. The inspection party will leave Dallas on a regular scheduled airliner for Corpus Christi, Texas, a distance of about 500 miles. There a two-hour inspection trip will be made of the Halliburton Cement Works. Of interest will be an 8000-hp Diesel installation and the manufacture of cement from sea shells.

The party will then fly to Victoria, Texas, a distance of 100 miles, where they will embark on buses for the Point Comfort Plant of the Aluminum Company of America, where they will inspect one of the largest installations in the world of internal-combustion engines.

In concept, in the number of miles traveled, in the size and novel application of the internal-combustion engines to be viewed, this tour is unique in recent ASME history. It offers an experience that members may not have an opportunity to duplicate for many years. Members who plan to attend the conference and to participate in the tour, should write to Oil and Gas Power Division, The ASME, 29 West 39th Street, New York 18, N. Y., for particulars.

C. A. Besio, assistant professor of mechanical engineering, Southern Methodist University, Dallas, Texas, and past-president of the South Texas Section, is chairman of the general arrangements committee of the conference.

Board on Public Affairs Takes Up Varied Agenda

ORGANIZATION of the Engineers Civic Responsibility Committee on a permanent basis as provided for in the ASME constitution, and requests from Bogota, Columbia, and Istanbul, Turkey, were some of the items considered during the meeting of the Board on Public Affairs held in New York, N. Y., on Feb. 15, 1951.

The Board on Public Affairs is the top-level body in the ASME which under the direction of Council supervises ASME activities relating to co-operation with governmental agencies in engineering matters and Society participation in international activities and programs aiming at larger participation by engineers in public affairs.

D. Robert Yarnall, past-president ASME; H. E. Martin, director at large; L. B. Jones, chairman, Engineers Civic Responsibility Committee, A. A. Potter, M. X. Wilberding, and W. L. Cisler, members at large, attended the meeting.

The Board agreed that the Engineers Civic Responsibility Committee should be established on a permanent basis as provided by the constitution, and that the Committee include past-presidents who wish to serve. The Board felt that an advisory committee composed of representatives of the various ASME Regions appointed by the respective vice-presidents, would be useful in promotion of civic responsibility.

ASME Activities in Bogota

According to S. I. Roudebush, there are eight members of the Society residing in Bogota, Columbia, South America. The group is interested in establishing an ASME Group. Mr. Roudebush suggested that ASME membership in Bogota could be substantially increased if an ASME Group was functioning there. The Board recommended, however, that Mr. Roudebush organize an ASME activity on an informal basis without formal Society support.

Student Branch in Turkey Requested

The faculty of Robert College, Istanbul, Turkey, submitted a request for establishment of an ASME student branch. The matter was referred to the Board on Public Affairs after having been considered by the vice-presidents who asked the Board for an opinion. The Board agreed that rather than establish a student branch so remote from the continental limits of the United States, some provision be made for students at Robert College to subscribe to MECHANICAL ENGINEERING at a special rate.

The Board also reviewed the Society's promotion of international relations and expressed the opinion that the Society should be represented at the 1951 conference of the Engineering Societies of Western Europe and the United States, to be held in Amsterdam, The Netherlands, during the week of Sept. 17, 1951.

Nuclear-Energy Programs Attract Large N. Y. Attendance

WIDE interest among engineers in the New York metropolitan area in problems associated with nuclear energy is reported by R. W. Cockrell, chairman, Nuclear Energy Division of the Metropolitan Section of The American Society of Mechanical Engineers.

The Nuclear Energy Division is the latest professional division created by the ASME Metropolitan Section. It was organized in October, 1950, to make available engineering information on nuclear energy released by the Atomic Energy Comission.

To overcome the security obstacle, the Nuclear Energy Division set about to register all members interested in its work. Only registered members are permitted to attend its meetings.

Mr. Cockrell reported that 350 engineers, representing 150 engineering firms in the New York area, have registered for the program of three meetings which began in October, 1950. Of the registered members about 70 per cent attended at least one meeting. Engineering applications of nuclear energy was the subject of the October meeting. At the second meeting engineering problems of nuclear energy were taken up. Attendance at both meetings was more than 170. The third meeting scheduled for May 19, 1951, will be an all-day field trip to the Brookhaven National Laboratory, Upton, L. I., N. Y.

Members who wish to take part in the May field trip and who are not yet registered, should write to R. W. Cockrell, c/o The M. W. Kellogg Company, 225 Broadway, New York, N. Y.

Research an Essential Part of ASME Special Committee Finds

Traditional Society Policy Reaffirmed in Report

PROMOTION of research is an important and necessary activity of a professional engineering society and one that The American Society of Mechanical Engineers must pursue actively by searching for needed research projects, outlining research programs, and soliciting funds from those who can benefit from the results of the projects.

Reaffirmation of traditional ASME policy was the sense of a report submitted recently to the Executive Committee of Council by a Special Committee on Research Policy composed of: E. G. Bailey, vice-president, The Babcock & Wilcox Company, New York, N. Y.; John Magos, director of research, Crane Company, Chicago, Ill.; and Ralph Sherman, director, Battelle Memorial Institute, Columbus, Ohio.

The Special Committee was appointed in November, 1950, to study methods for providing support for Society research activities. In the course of its studies, the Committee reviewed the history of ASME research and asked itself some fundamental questions about the responsibility of a professional society regarding search for new knowledge. In addition to reaffirming traditional ASME policy, the Committee recommended some changes in the Research Committee structure which will bring the Professional Divisions into positions of greater responsibility.

ASME Research History

Supporting the Committee conclusion is the long history of research sponsored by the ASME. Since 1920 the Society dispersed total funds for research amounting to $1,100,000. This sum is exclusive of research done under government contracts valued at $120,000, equipment and facilities contributed to the Society research by industrial organizations worth $350,000, or the value of time and expenses contributed by individuals who served on committees.

ASME research contributions are well known all over the world and provide the

engineering profession with knowledge which finds daily application. ASME has been responsible for research on properties of steam, measurement of fluid flow, boiler-furnace refractories, properties of metals at high temperatures, furnace-performance factors, pressure-viscosity characteristics of lubricants, and the characteristics of high-pressure steam.

Basic Questions Asked

Before arriving at conclusions, the Special Committee asked itself the following three basic questions:

1 Should the Society continue to carry on research activities?

2 If the answer to the first question is affirmative, should the Society actively and aggressively seek to expand its research activities or should it merely be prepared to care for what might come its way?

3 How can the research activities the Society is prepared to undertake be best administered and how shall they be best financially supported?

The Committee found it inconceivable that the ASME could discharge its responsibility without carrying on research. On the second point, there was unanimous agreement that the Society must take the initiative to search out research projects which cut across company and industry boundaries, projects which the ASME is perhaps best qualified to promote. The Society should call attention to needed research from which industry stands to benefit. It should suggest outlines for research projects and obtain from industry the financial support for their execution.

The Committee noted that government research laboratories, universities, foundations, and private research institutions were competing for available research dollars. If the ASME assumed a passive policy and stood by expectantly for industry to ask the ASME to undertake research, then "the wheels of its research may grind exceedingly fine, but they will also move slowly and grind exceedingly little."

ASME Calendar of Coming Events

April 2–5
ASME Spring Meeting, the Atlanta Biltmore, Atlanta, Ga.
(Final date for submitting papers was Dec. 1, 1950)

April 16–18
ASME, Region VIII, Annual Meeting, Hotel President, Kansas City, Mo.

April 17–19
ASME Process Industries Division Conference, Lord Baltimore Hotel, Baltimore, Md.
(Final date for submitting papers was Dec. 1, 1950)

June 11–15
ASME Semi-Annual Meeting, Hotel Royal York, Toronto, Ont., Can.
(Final date for submitting papers was Feb. 1, 1951)

June 22–23
ASME Applied Mechanics West Coast Conference, Stanford University, Stanford, Calif.
(Submit papers through J. N. Goodier, Division of Engineering Mechanics, Stanford University)

June 25–29
ASME Oil and Gas Power Division Conference, Baker Hotel, Dallas, Texas
(Final date for submitting papers was Feb. 1, 1951)

Sept. 10–14
ASME Industrial Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Houston, Texas
(Final date for submitting papers—May 1, 1951)

Sept. 24–26
ASME Petroleum Mechanical Engineering Conference, Hotel Mayo, Tulsa, Okla.
(Final date for submitting papers—May 1, 1951)

Sept. 25–28
ASME Fall Meeting, Hotel Radisson, Minneapolis, Minn.
(Final date for submitting papers—May 1, 1951)

Oct. 11–12
ASME Fuels and AIME Coal Divisions Joint Conference, Hotel Roanoke, Roanoke, Va.
(Final date for submitting papers—June 1, 1951)

Nov. 25–30
ASME Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.
(Final date for submitting papers—July 1, 1951)
(For Meetings of Other Societies see page 359)

Actions of The ASME Executive Committee

At a Meeting at Headquarters Feb. 27, 1951

A MEETING of the Executive Committee of the Council was held in the rooms of the Society on Feb. 27, 1951. J. Calvin Brown, chairman, presided. In addition to Mr. Brown there were present: Frank M. Gunby, vice-chairman; Albert C. Pasini, Thomas E. Purcell, William M. Sheehan, of the Executive Committee; W. P. Saunier (Organization Committee); E. G. Bailey, past-president ASME; H. R. Kessler, vice-president; Edgar J. Kates, assistant treasurer; R. A. Sherman; C. E. Davies, secretary; and Ernest Hartford, executive assistant secretary.

Manpower Commission

A sum of money was contributed from the Development Fund to the EJC Engineering Manpower Commission to support its work.

Power Test Codes

Upon recommendation of the Organization Committee, the name of the Power Test Code No. 25 on Testing and Rating of Safety and Relief Valves was changed to PTC Committee No. 25 on Safety and Relief Valves.

Public Relations

It was agreed to discuss with the vice-presidents the possibility of greater use by Sections of the publicity service and it was voted that the entire publicity program of the Society should be reviewed by the Board on Technology to determine whether funds are well spent or whether some other methods of publicity should be used.

Materials Handling Handbook

Preparation and publication of a "Materials Handling Handbook," proposed by the Materials Handling Division and recommended by the Board on Technology, was approved on condition that contents would be subject to approval of the Publications Committee and that no appropriation would be requested from the Society for the project.

International Relations

Upon recommendation of the Board on Public Affairs, the secretary was authorized to attend the Conference of the Engineering Societies of Western Europe and the United States to be held in Amsterdam, The Netherlands, in September, 1951, and, if possible, the Heat Transfer Discussions to be held in London, also during September.

Sections

Upon recommendation of A. C. Pasini, vice-president, ASME Region V, it was voted to include the following counties as part of the Columbus Section: Delaware, Fairfield, Fayette, Franklin, Hocking, Knox, Licking, Madison, Marion, Morrow, Muskingum, Perry, Pickaway, Ross, Union.

Review of ASME Activities

President J. Calvin Brown announced the appointment of E. G. Bailey, H. V. Coes, and A. R. Mumford as members of a planning committee to review ASME objectives, organization, and changes needed in organization structure, and long-term objectives. The Executive Committee authorized the Planning Committee to add to its personnel as the program develops.

Manual of Council Policies

The Committee expressed appreciation to A. R. Mumford for his part in preparing a manual of Council policies.

Power Show

Agreement with the International Exposition Company regarding ASME participation in the 1952 National Exposition of Power and Engineering to be held in New York, N. Y., was authorized.

Use of Society Emblem

Permission was granted to the ASME student branch at the University of South Carolina to use the ASME emblem on the key and a certificate to be awarded to an outstanding mechanical-engineering student.

Certificates of Award

Upon recommendation of J. T. Rettaliata, vice-president, ASME Region VI, a certificate of award was granted to John G. Davies, retiring chairman of the Minnesota Section.

Upon recommendation of the Publications Committee a certificate of award was voted to Frederick Lask, a member of the ASME staff for 37 years, who had served the Society as advertising manager since 1919.

A policy of awarding certificates for outstanding leadership and development of stand-

ards and codes sponsored by the Society was approved.

Institution of Mechanical Engineers

Congratulations and best wishes were extended to Brian E. Robbins, new secretary of The Institution of Mechanical Engineers. A message of appreciation was authorized to Sir Henry Guy, retiring secretary, for his fine cooperation with the ASME. Reciprocal membership and privileges in accordance with the policy of the Society were extended to Mr. Robbins.

W. L. Abbott

The death of W. L. Abbott, past-president and Honorary Member, ASME, on Feb. 20, 1951, was noted with regret.

Appointments

Appointments to Society boards, committees, and joint activities recommended by the Organization Committee were approved

The following presidential appointments were confirmed: Alf Kolflat to represent the Society at the Washington Award Dinner; W. L. Batt and A. C. Townsend, as ASME representatives to the Joint Engineering Conference in London, June, 1951; W. J. Kinderman and G. M. Muschamp as ASME representives to American Academy of Political and Social Science annual meeting.

ASME Standards Workshop

Track Bolts

A PROPOSED revision of the American Standard Track Bolts and Nuts (ASA B18) was recently published by The American Society of Mechanical Engineers and is now being distributed to users for criticism and comment.

The revision is the work of Sectional Committee B18 which since its reorganization in February, 1947, studied all types of track bolts and nuts used by various railroads and electric railways in the United States and Canada, and conducted a program of static and torsion testing to arrive at the best engineering design, taking into account present-day joint bar designs, use of power wrenches, and other factors.

The proposed revision allows for adequate tolerances to encourage good manufacturing practices and to facilitate production inspection.

Copies of the proposed standard for comment may be obtained from ASME Standards Department, 29 West 39th Street, New York, N. Y.

Instruments and Apparatus

EXTENSIVE revision of Supplements on Instruments and Apparatus to the ASME Power Test Codes was inaugurated at the first meeting of the recently reorganized PTC Committee No. 19 held during the 1950 Annual Meeting of The American Society of Mechanical Engineers in New York, N. Y.

The 21 supplements to Power Tests Codes produced by the Committee since its organization in 1918, will be revised to include recent developments in the instruments field. These supplements contain general discussion of types of instruments, methods of measurements, limits and sources of error, corrections, calibrations, and other instrumentation factors helpful to users of ASME Power Test Codes. The Committee's first task will be to study the instrumentation needs of all power test codes.

The work will be headed by C. F. Kayan, associate professor, Columbia University, New York, N. Y., and will be divided among six subcommittees. Chairmen of subcommittees and supplements assigned to each for revision follow:

Subcommittee A; *Chairman*, W. C. Andrae, associate professor, department of heat-power engineering, college of engineering, Cornell University, Ithaca, N. Y. *Assignment of Supplements*, (2) Pressure Measurement; (4) Head Measurement; (15) Measurement of Surface Areas; and (16) Density Determinations.

Subcommittee B; *Chairman*, W. A. Hadley, assistant professor, department of mechanical engineering, Columbia University, New York, N. Y. *Assignment of Supplements*, (3) Temperature Measurement; (17) Determination of the Viscosity of Liquids; and (18) Humidity Determinations.

Subcommittee C; *Chairman*, H. S. Bean, chief, capacity, density, and fluid meters section, mechanics division, National Bureau of Standards, Washington, D. C., (5) Measurement of Quantity of Materials; (12) Measurement of Time; (13) Speed Measurements, and (14) Linear Measurements.

Subcommittee, D; *Chairman*, G. S. Peterson, section head, Gulf Research and Development Company, Pittsburgh, Pa.; *Assignment of Supplements*, (9) Heat of Combustion; (10) Flue and Exhaust-Gas Analyses; and (20) Smoke-Density Determinations.

Subcommittee E; *Chairman*, A. R. Spalding, assistant professor, mechanical-engineering department, Purdue University, Lafayette, Ind.; *Assignment of Supplements*, (6) Electrical Measurements; (7) Measurement of Power by Means of Dynamometers; and (8) Measurement of Indicated Horsepower.

Subcommittee F; *Chairman*, M. W. Leonard, mechanical division chief, test laboratory, Public Service Electric & Gas Company, Maplewood, N. J. *Assignment of Supplements*, (11) Determination of Quality of Steam; (19) Measurement of Impurities in Feedwater and Steam; and (21) Leakage Measurement.

The subcommittees will also take under consideration at once a number of special problems included in queries by users of the Power Test Codes and Supplements.

Screw Threads

FRANK P. TISCH, chief product engineer, Pheoll Manufacturing Company, Chicago, Ill., was appointed recently to the chairmanship of Sectional Committee B1 on Standardization and Unification of Screw Threads. He succeeds Elmer J. Bryant who died on Jan. 30, 1951.

Plumbing Code

DRAFT of a proposed national plumbing code, which incorporates the best features of five plumbing codes currently in use on a national level, was incorporated into a report of The Co-Ordinating Committee for a National Plumbing Code and approved for distribution to the co-operating organizations for their consideration, at a meeting held in Washington, D. C., Jan. 4, 1951.

The unified code is based on the following existing codes: (1) The American Standard Plumbing Code sponsored by The American Society of Mechanical Engineers and the American Public Health Association; (2) the Uniform Plumbing Code of the Department of Commerce; and (3) the Western Plumbing Officials Code, widely used in 13 western states. Two other codes in process of compilation by the Building Officials Conference of America and the American Society of Sanitary Engineers were considered in the new national code. F. M. Dawson, dean, College of Engineering, University of Iowa, Iowa City, Iowa, and chairman of the Co-ordinating Committee, and Albert H. Morgan, deputy commissioner, Department of Public Works, City of New York, N. Y., represented The American Society of Mechanical Engineers at the Washington meeting. Other organizations represented were: American Public Health Association, American Society of Sanitary Engineers, Building Officials Conference of America, Conference of State Sanitary Engineers, National Association of Master Plumbers, National Bureau of Standards, Uniform Plumbing Code, and Western Plumbing Officials Association.

The draft of the proposed national code will be reviewed by the sponsors of the several codes and other interested organizations with a view to revising existing codes.

Air Pollution

A NINE-POINT proposal spelling out how The American Society of Mechanical Engineers can contribute most effectively to the solution of national air-pollution problems, was adopted by the Steering Committee of the ASME Air Pollution Controls Committee at a meeting in New York, late in 1950. The proposal was presented by A. R. Mumford, development engineer, Combustion Engineering Superheater, Inc., New York, N. Y., the chairman of the Scope Subcommittee which formulated the proposal.

The ASME Air Pollution Controls Committee was created in 1949 as the result of the report, "Example Sections for a Smoke Regulation Ordinance," prepared by the Model Smoke Law Committee of the ASME Fuels Division. Wide distribution of this report revealed the need for documents which approach control of air pollution from a broader base than that of smoke alone.

Some 30 organizations known to be interested in air pollution were invited to send representatives to a meeting in New York, N. Y., in November, 1949, to organize a program for

ASME participation in the problem of air-pollution control.

At that time, T. E. Purcell, general superintendent, power stations, Duquesne Light Company, Pittsburgh, Pa., was elected chairman and was authorized to appoint two subcommittees, one on scope and the other on organization.

The Scope Committee's first recommendation concerned preparation and publication of a historical summary of the problem of air pollution. They suggest a book that would include abstracts of important documents, reports, and technical papers useful to workers in air-pollution control.

Publication of a pamphlet of loose-leaf sheets which would make available current information on air-pollution projects and trends of control by manufacturers and public offices, was the second recommendation. Since many organizations are at work on different phases of the problem, the Steering Committee felt that such a service was needed, but that it would be necessary to avoid duplication of effort, and that the Society might well act as a clearinghouse for such information.

The third project was promotion of a series of authoritative papers defining and redefining substantial economic and public-health requirements for the abatement of nuisances and troublesome emissions. These papers the Committee felt should differentiate between the requirements of dust-free atmospheres under various conditions, for example, those in hospitals, paper mills, food-processing plants, cement mills, and others.

The ASME through its Air Pollution Controls Committee could also encourage preparation of economic analyses to show the dollar efficiencies of degrees of pollution abatement and the effect on communities or neighboring industries. In considering this recommendation the Committee agreed that the economic aspect of air-pollution control could not be ignored.

Proposal six suggested that the Society foster studies of fuel use in all categories by areas and the relationship of emission to types of equipment and the use of all types of fuel in the best equipment.

Research data defining upper limits of emission as influenced by topography, meteorology, and stack-discharge position, would be helpful. The Committee agreed there was insufficient reliable information on the influence of terrain on air pollution and that the Society should co-operate with the American Meteorological Society in this aspect of the problem.

The final proposal was a project for developing and codifying measurements of contamination as to a method for accuracy, for approximation, and visual checks as to density.

Subcommittees are currently being organized to undertake the projects recommended by the Scope Subcommittee.

Junior Forum

Nontechnical Reading for Engineering Graduates

Great Books Program Discussed

THE question of what nonengineering books a young engineer should read to broaden his knowledge was one of the topics discussed at the Junior Conference held at the 1950 Annual Meeting. W. B. Embler, head of the department of the humanities, Cooper Union School of Engineering, New York, N. Y., who covered this subject, suggested that the engineering graduate might begin his reading by reading what he likes to read rather than what he thinks he should read. He also said that one of the best reasons for reading was the challenge to change one's mind.

The following comment on Professor Embler's talk was submitted by C. B. Haughton, Jr., aircraft-gas-turbine engineering division, Aircraft Gas Turbine Laboratory, General Electric Company, Lynn, Mass.

Professor Embler presented in a stimulating and witty manner an appeal to both junior and senior engineers to improve their professional knowledge by revamping their reading habits. He suggests that the highest reason for reading is "to change your mind" and presents a list of nontechnical books, all written within the present century, which he believes are provocative enough to effect such a transformation, provided the reader is open-minded enough to begin with.

The writer would like to express some concern over the fact that Professor Embler made no mention of reading the classics of the past to any great extent. While modern works are equally stimulating and often present, in a different context, the same ideas as the classic writers, it is refreshing and often extremely revealing to read them from the point of view of the ancient Greeks and Romans and the Middle Age-French, English, and Italians, to mention a few. Especially when these books are read and discussed as part of a group are the benefits greatest. Professor Embler agreed that the modern nonfiction books frequently suggest a return to the ancient writings but felt that the necessity for reading the modern authors was more urgent because we need to see and understand important problems in their immediate ideological and physical environment.

Great Books Program

For the benefit of junior (and senior) engineers who might be interested in more about the Great Books Program, I would like to mention what some of us in the General Electric Company at Lynn, Mass., have done.

In the summer of 1948 the Lynn General Electric Engineers Council, as part of its general program of professional and community activities, inaugurated a campaign to interest all employees of the two Lynn works of the company in taking part in Great Books discussions. The response was sufficient to establish in the following fall and spring months about eight groups of about 15 persons each, and these groups were predominantly composed of General Electric engineers and their wives. A leaders course, under the direction of the regional director of the Great Books Program, whose headquarters are at Chicago, was first organized among members of the council, and when this closed, the real discussions and readings were started.

A Great Books discussion is a stimulating affair. After spending about two weeks individually reading each classic, the participants gather together around a big table in some convenient library or meeting hall, and begin their battle of words. Two leaders alternately ask significant questions to keep the discussion going. They are not allowed to make statements themselves, nor to summarize the discussion, but merely try to ask the questions which they believe will be most stimulating. The ideal situation, seldom realized, is for one leader to ask such a powerful first question that the discussion, throughout the evening, proceeds on this one alone, is added to by all participants, and never significantly deviates from the subjects. Many great questions are so controversial that no final answers are found, which to some participants is disappointing. Rather, such answers as are necessary are generally left to the individual to provide. In any case, once the search for truth is under way, the individual may and does often find himself doing parallel reading, having heated discussions with his wife, and in the office, and generally finding that the questions asked by the old Greeks and Romans have a surprisingly familiar ring today.

Library Masterpieces Discussed

The readings on the first-year list include such masterpieces as Thucydides' "History of the Peloponnesian War," which has an amazing parallel with the forces and ideas at war today; "The Declaration of Independence," which has such profoundly controversial questions in its first paragraph that most groups find that they cannot proceed beyond it; and the "Communist Manifesto," whose distortions (to the democratic mind) should be read by everyone seeking to understand the communist mind today.

The second-year readings get longer and more difficult and include Homer's "Odyssey," Swift's "Gulliver's Travels," Kant's "Metaphysical Elements of Ethics" and Tawney's "Religion and the Rise of Capitalism."

Successive years readings become more abstract but are equally as stimulating as the earlier ones, and one finds that his perception and understanding, and particularly his articulateness concerning many age-old questions, will increase extensively.

After the first-year discussions had terminated, during the next fall other groups were organized within the several communities near the two General Electric Works. These are

now meeting, usually during the winter months, for about twenty sessions at two-week intervals. Many persons initially interested have dropped out, but those remaining are more enthusiastic than ever and are instrumental in getting new members to join.

I would like to emphasize that not the discussion leaders but Socrates, Job, Aristotle, Homer, Milton, Rousseau, and a thousand others are the teachers; that the Great Books discussion groups are a means to self-education that is exceedingly useful personally and professionally; and above all that these discussions are a democratic means for examining and re-examining the great issues which underlie our unsettled society.

Sir Richard Livingstone of Oxford University summed up the need for adult education very effectively when he said that, "all of us need a renewal of education, after we have lived in the world and learned something about life; so that we get a chance of thinking afresh about religion, philosophy, history, politics, economics, literature, and art, when we have seen at firsthand the raw material with which they deal, so that we can for a moment withdraw from the turmoil, and consider our age and ourselves in the light of eternal principles and issues. In adult education—not merely of a technical and vocational, but of a liberal type—I see the greatest hope for the future. But we have not yet taken it seriously."

For those who need to take our professional education more seriously an earnest attempt should be made to act by Professor Embler's suggestions as well as to take part, individually and in groups, in intellectual readings and discussions which will help to further our education and make us capable of greater professional and personal responsibility to ourselves and our fellows.

Comments by W. B. Embler[1]

Since in my paper "Nontechnical Reading," I was interested primarily to say something which I hoped would be of value to a specified audience of young engineering graduates, I chose to present a list of books and a plan of reading which it occurred to me the recent graduate could well follow for his current reading. I felt that the particular audience whom I was invited to address might find profitable an examination of significant contemporary thought which would help them to form a fresh and modern point of view toward the vexing issues of our day. It would be the rashest kind of folly to insist categorically that one should not read the great books, just as it would be shortsighted to insist that only they should be read. Naturally, I think that adults should not neglect the written monuments of their culture. Lacking the wisdom and consolations of philosophy we should be poor indeed. Hence I endorse wholeheartedly the program which Mr. Haughton outlines, and it is cheering to know that there are groups of adults who elect to gather in concert to study the great books.

But surely there is room in our lives for both the contemporary and the older literature and philosophy. The choice is not, I hope, an "either/or" one. Moreover, most undergraduates are introduced, or should be introduced, to the classics in their college years. After graduation the young engineer should be encouraged to explore the thought of his most thoughtful and provocative contemporaries. As is demonstrated in Mr. Haughton's comment, the wish to return to the great books will grow almost of itself; and when in the fullness of their maturity adults return to the classics, it will be with minds more receptive to the subtleties and to the universality of great thought and great art.

[1] Professor of English, and head of the Department of the Humanities, Cooper Union School of Engineering, New York, N. Y.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or not, and is operated on a nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York
8 West 40th St.

Chicago
84 East Randolph Street

Detroit
100 Farnsworth Ave.

San Francisco
57 Post Street

Men Available[1]

MECHANICAL ENGINEER, 29, married, BSME, one year's experience in research, design, development; last seven months on high-pressure pneumatic and hydraulic valves. Presently employed. Me-812.

PROJECT ENGINEER, automatic machinery, 29, BME, seven and a half years' experience design, development, and building of machinery. N. Y. State Professional License. Will relocate. Me-813.

PROFESSOR, 66, married, graduate 1911; 30 years head of mechanical-engineering department, university in Philippines. Ten years with six American universities. Varied practical experience during vacations. Shop, design, and allied courses. Desires mild climate. Me-814-511-D-3.

MANUFACTURING ENGINEER, 15 years prime responsibility circuit-controlling devices, radar, television, other products. Wide experience factory management; production, tool engineering; manufacturing techniques; "gadgeteering"; drafting standards. Intimate shop experience. Part-time college instructor. Me-815.

MECHANICAL ENGINEER, 24, three years responsible position geophysical exploration. Desires permanent position, engineering or geological. Prefers oil or mining industry or consulting firm, permanent location. Me-816.

Positions Available

DESIGN-DRAFTSMEN, 22–28, mechanical or electrical graduate, for board-design work on turbines, centrifugal compressors, and heavy-rotating electrical apparatus, covering continuous development on machinery in regular commercial production. Salary open. Western Pa. Y-3923.

PROJECT ENGINEER, 28–38, mechanical graduate, development and design experience, and experience in thermodynamics, fluid-flow, and heat-exchanger equipment. Any process experience in the maintenance of refrigeration equipment desirable. Should be familiar with low-temperature and high-vacuum techniques. Will develop liquefied-gas equipment and will carry on into manufacturing phases. Salary open. Mass. Y-4971.

INDUSTRIAL-MANAGEMENT ENGINEER, 38–42, well-rounded industrial-plant layout, production-control, wage-incentive experience for firm of management consultants. $7500. Headquarters, Eastern Pa. Y-4995.

MACHINE DESIGNER, 30–40, mechanical-engineering graduate, at least five years' process and special-machinery experience, to design textile and rubber machines. $4500–$5400. Northern N. J. Y-4998.

DEVELOPMENT ENGINEER, young, mechanical graduate, eight to 12 years' experience, mostly in machine design. Should preferably have experience in the packaging-machinery or allied fields, as development program consists primarily of the design and development of packaging machinery. Should know good drafting practice, tooling, and manufacturing procedures. $6500–$8500. Northern N. J. Y-5006.

SALES ENGINEER, mechanical graduate, 30–36, several years' industrial-sales experience and some knowledge of steam traps. Salary open. Territory, Chicago, Ill. Y-5032C.

MECHANICAL ENGINEER, under 40, for product design and tool engineering for company engaged in plastic injection for toys, etc. $7800. Northern N. J. Y-5034.

MECHANICAL ENGINEER, 30–40, for service work on motors, wiring, and pumps for elevators. Will contact management for general maintenance work. $7500–$9000. New York, N. Y. Y-5035.

ENGINEERS. (*a*) Machine designers, 30–50, mechanical degree, at least five years' experience designing industrial-production machines, to design automatic and semiautomatic production machines, some high speed, and to design process equipment and laborsaving devices, etc. Up to $7200. (*b*) Methods engineer, 25–40, engineering or technical background preferred. Should have practical experience in the methods field, including motion analysis, equipment economy, and general knowledge of the application of manual work combined with machine work. Should have general knowledge of over-all engineering practice. $4500–$6000. (*c*) Time-study engineers, minimum of three to five years' experience in the time-study field, preferably having worked with the Standard Data System of Methods Time Measurement or Work Factor. Technical knowledge of time-study and practice is a secondary factor, as there will be an intense training program for time-study engineers. Should have had considerable working experience. $2700–$4800. Del. Y-5037.

PLANT ENGINEER, mechanical graduate, for a paper mill in South Carolina. Will be in charge of mechanical, electrical, and civil engineers, and need not necessarily have paper-mill experience. $10,000–$12000. Y-5055.

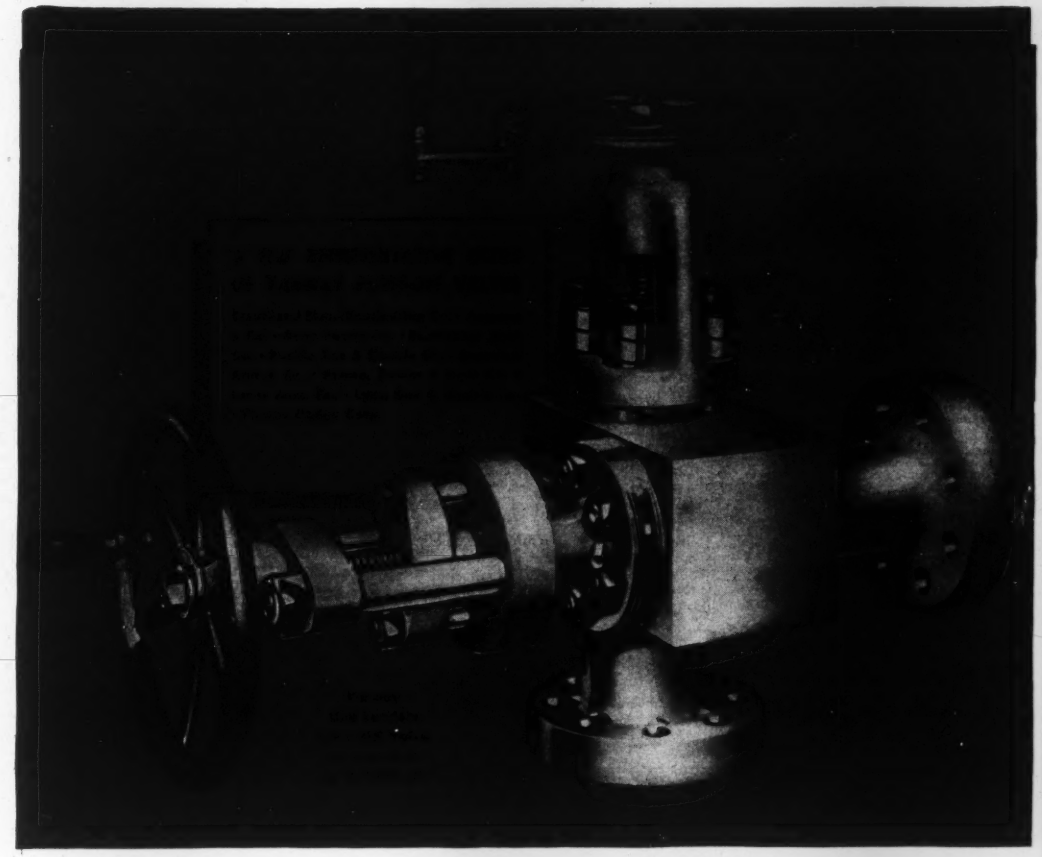
CHIEF ENGINEER experience in compression plastic molding. Will take charge of maintenance, spare parts, design of molds, etc., for plant employing 60 to 70 people. $6000–$7200. Southern N. J. Y-5059.

FIELD ENGINEER AND DRAFTSMAN, 25–35, mechanical graduate, three years' experience; or high-school graduate with eight years' experience, to do finished drawings of piping, equipment, and machine layouts. Ability to make freehand sketches from working parts. Should have sufficient knowledge of job to make initial layouts; follow shopwork until completion and final installation. $3600–$4200. Del. Y-5061.

ENGINEERS. (*a*) Design engineers minimum of 10 years' current or recent aircraft experience. Must have had responsibility for design of important components such as wing, fuselage, etc. $9464. (*b*) Design layout draftsman minimum

(*ASME News continued on page 370*)

[1] All men listed hold some form of ASME membership.



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of seven years' current or recent experience. Will be responsible for design of fairly major aircraft components such as wing spar, sliding-canopy fuel system, complete aileron-flap empennage. $6664. (c) Layout draftsman minimum of three years' experience in aircraft drafting. To $5824. New York, N. Y. Y-5081.

PLANT MAINTENANCE ENGINEER, 30–50, chemical-engineering degree, who has had heavy plant-maintenance experience. $6000–$7200. Northern N. J. Y-5088.

ENGINEERS. (a) Senior time-study engineer, degree in industrial engineering, or administrative, or mechanical engineering with industrial-engineering option, and at least four years' experience in progressive professional time-study engineering and work measurement of substantial professional difficulty and importance in shop, office, or laboratory. $5000. (b) Junior time-study engineer at least two years' experience for above work. $4000. N. J. Y-5091.

CHIEF MANUFACTURING ENGINEER, 35–50, degree in mechanical or industrial engineering and broad background of practical and technical experience for manufacturer of rod, tube, forgings, and fabricated nonferrous products, to investigate manufacturing problems and make recommendations on plant layout, manufacturing methods, tool and die design, sales estimating engineering. Mich. Y-5095-R-7524-D-6680.

ENGINEERS. (a) Design engineer, mechanical graduate, at least four years' experience on internal-combustion engines or compressors. $5000, and up depending on qualifications. (b) Development engineer, mechanical graduate, at least four years' experience in testing and development of internal-combustion engines or compressors. Must be able to assume responsibility. $5000 or more, depending on qualifications. (c) Research and development engineer, recent mechanical graduate, interested in testing and development work on internal-combustion engines and compressors, or turbomachinery. $3500 and up, depending on qualifications. Company will pay moving expenses and employment fees. Western N. Y. State. Y-5122.

CHIEF ENGINEER, 40–50, mechanical graduate, to be completely responsible for supervising 30 to 40 engineers in structural, mechanical, and electrical engineering. Company manufactures marine and heavy industrial equipment. $10,000–$15,000. Md. Y-5128.

PRODUCTION DESIGNER to take complete charge of designing and tooling for production, research models of sheet metal, valves, pumps, etc. Should have 10 to 12 years' experience. $7500. Northern N. J. Y-5132.

MECHANICAL ENGINEER, graduate, 38–50, preferably married. Must have had machine-shop experience and experience in erection, repair, and maintenance of commercial-printing equipment. Must be capable of planning and executing plans for preventive maintenance. Must be qualified to head department with supervision over two good mechanics. Subject to call 24 hours a day, regular work week eight hours a day, five days a week, with plant operating three shifts. Entire plant open shop. $6000. Tenn. R-7523.

DESIGNER, graduate, mechanical-engineering, experienced in design of heavy machine tools. Knowledge of design and manufacturing, to take complete charge of design and follow through on heavy equipment for a manufacturer of heavy machinery. Salary open. Ill. R-7525.

Fellowships

A NUMBER of research fellowships in applied sciences related to welding, offered by several industrial firms, are being administered by The Welding Research Council of The Engineering Foundation. Stipends range from $1800 for a single man to $2500 for a married man. Work may be undertaken at any university approved by the Fellowship Board.

Two other fellowships are being offered by the Plasticity Committee of the Council. The purpose of these is to stimulate original thought leading to creation of new knowledge or better utilization of existing knowledge to avoid brittle failures. Plasticity fellowships carry an award of $3500 covering stipend and research costs.

For information write to W. Spraragen, Director, Welding Research Council, 29 West 39th Street, New York 18, N. Y. Applications close June 1, 1951.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after April 24, 1951, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

ALLEN, JACK W., New Orleans, La.
ALSUP, W. W., Shreveport, La.
ALTORFER, KENNETH J., Metuchen, N. J.
ANDERSEN, E. B., Petersham, Mass. (Rt&T)
ANDERSON, C. T., Kansas City, Mo.
ANGER, EDWIN, Tempe, Ariz.
ATTLER, ANTHONY R., Long Island City, N. Y.
AVERY, DON E., Seattle, Wash.
BADENHOPE, JOHN G., Toledo, Ohio
BARNA, PETER S., Leura, New South Wales
BARTMAN, JAMES S., Middletown, Pa.
BENNETT, JAMES E., Philadelphia, Pa.
BLANCHARD, LEE J., Lafayette, La.
BLYTHE, GEORGE E., Croydon, Surrey, England
BRAMSON, MORTON A., New York, N. Y.
BROCKETT, GLENN F., Marshalltown, Iowa
BRODIE, JAMES H., Ruxton, Md.
BROWN, HERMAN, Houston, Texas
BROWNLEE, J. A., Shawinigan Falls, P. Q., Can.
CARDGNA, FRANK A., Baltimore, Md.
CEPPERLEY, FLORIAN F., Charleston, W. Va.
CHAISSON, W. P., Swansea, Mass.
CHASE, CHARLES C., Shrewsbury, Mass.
DAILEY, EDGAR G., Philadelphia, Pa.
DARLING, RAYMOND A., Tulsa, Okla.
DELIBERT, JOSEPH C., Lynbrook, N. Y.
DEVEDIA, R. MARTINEZ, Buenos Aires, Argentina
DONNELLY, R. E., Fitchburg, Mass.
DWIGHT, R. W., JR., Baltimore, Md.
ETLAR, JOHN RUSKIN, Baltimore, Md. (Rt)
FAWCETT, WILLIAM E., Latrobe, Pa.
FORD, JAMES A., Concord, Mass.
FRENCH, FRANCIS H., Baltimore, Md.
GILLES, WILLIAM F., Homewood, Ill.
GOOCH, ROBERT M., Huntsville, Ala.
GOTTFRIED, MAURICE K., Port Chester, N. Y.
GREENLAW, WILBERT D., Belmont, Mass.
GRIMAC, HENRY, Oak Ridge, Tenn.
GUY, ARTHUR M., Jackson, Mich.
HAMLIN, JAMES B., Denver, Colo.
HEGETSCHWEILER, HEINRICH, Schenectady, N. Y.
HOLM, RUSSELL H., Detroit, Mich.
INGLESE, LOUIS, Catasauqua, Pa.
JOHNSON, W. E. P., London, England
JONES, HOMER D., JR., Barrington, R. I.
KELLY, NATENIS, Bradford, Mass.
KOCHEY, EDWARD L., JR., Philadelphia, Pa.
KONDAL, RAYMOND R., Midland, Mich.
KRBEC, NORMAN J., Cicero, Ill.
LAIRD, WILLIAM M., Pittsburgh, Pa.
LANNER, ARNE, Kansas City, Mo.
LARSON, S. H., Kingsport, Tenn.
LEARY, ROBERT A., Glen Oaks, N. Y.
LEVE, BERYL, Detroit, Mich.
LISCHER, VANCE C., Kirkwood, Mo.
LYNCH, JOHN D., N. Quincy, Mass.
MAR, JAMES WAH, Lexington, Mass.
MARDICK, JOHN A., Brooklyn, N. Y.
MCFARLAND, MILTON C., Honolulu, T. H.
MELOSH, HENRY J., Glen Rock, N. J.
MEYER, KARLE B., Akron, Ohio
MILLER, WM. C., St. Paul, Minn.
MINNS, GEORGE A., Hamilton, Ont., Can.
MUDD, C. W., St. Albans, W. Va.
MUELLER, FREDERICK W., West Bend, Wis.
MULLINS (MARX), FREDERICK C., Bayside, N. Y. (Rt)
NACHTMAN, ELLIOT S., Chicago, Ill.
NEAL, BOB R., Tulsa, Okla.
NETTER, MILTON A., JR., Toledo, Ohio
NIELSEN, EDGAR W., Brooklyn, N. Y.
OLSON, M. B., Kennett Square, Pa.
PARKER, T. W., Larnaca, Cyprus
PENNINGTON, JOHN V., Houston, Texas (Rt&T)
PERKINS, GEORGE, Louisville, Ky.
PETERSEN, CONRAD W., Chicago, Ill.
PFUNDT, G. M., Churchville, Pa.
RICHARDSON, ERNEST L., Danvers, Mass.
RICHMAN, EUGENE, Jackson Heights, N. Y.
RIZZONE, MICHAEL L., Oil City, Pa.
ROBERTS, GEORGE F., Silver Spring, Md.
ROBSON, J. L., St. Paul, Minn. (Rt)
ROSENBERG, MORTON, Toms River, N. J.
RUPPE, ERNEST F., Louisville, Ky.
SAFIER, ROBERT, Brooklyn, N. Y.
SCHEIL, MERRILL A., Milwaukee, Wis.
SCOTTO, DOMINICK P., Bronx, N. Y.
SEWALL, EDWARD, JR., Coalinga, Calif.
SISLER, CHARLES W., Blytheville, Ark.
SKOPIC, JOHN, Schenectady, N. Y.
SPIRIDIGLIOZZI, FRANCIS D., Utica, N. Y.
STOCKARD, R. H., Kingston, R. I.
TAINI, JOHN, Chicago, Ill.
TAYLOR, C. E., Bronxville, N. Y.
TOWLER, FRANK H., Dob Park, Yorks., England
VEDAMANIKAM, F. J., Adyar, Madras, India
WIEDERSUM, GEORGE C., JR., Philadelphia, Pa.
WILMOT, KENNETH, Clitheroe, Lancs., England
WOOD, RAWSON L., Manhasset, N. Y.
WYATT, H. C., Roanoke, Va.

CHANGE IN GRADING

Transfers to Member and Associate

ALLAN, WALTER E., Waterbury, Conn.
ANDERSON, PAUL E., Hinsdale, Ill.
BELL, GRAHAM H., Montclair, N. J.
BENNER, LOUIS H., Charleston, W. Va.
BIBLE, WILLIS B., JR., Port Arthur, Texas
BIENSTOCK, GEORGE J., Larchmont, N. Y.
BODENSCHATZ, AUGUST, Philadelphia, Pa.
BREWSTER, J. I., Pomona, Calif.
BURTON, C. C., Freeport, Texas
CALDWELL, E. C., Richmond, Va.
DE VINE, DONALD F., Portland, Ore.
DOUBRAVA, EUGENE NELSON, Cleveland, Ohio
GARCIA, BERT H., JR., State College, Pa.
GILBERT, JAMES R., JR., Joliet, Ill.
HICKEN, FRANK L., Hickman Mills, Mo.
HOLBROOK, REX R., Ann Arbor, Mich.
HOLLS, FREDERICK D., Chicago, Ill.
HORNBAKER, WILLIAM S., Oak Ridge, Tenn.
HUTTON, JUNIUS A., Chevy Chase, Md.
JACOBS, LEONARD, Philadelphia, Pa.
JOHNSON, ELMER G., Fairborn, Ohio
KALISZ, WALTER J., Anderson, Ind.
KNAPP, CHARLES A., Springfield, Pa.
LANGE, H. FREDERICK, Peoria, Ill.
MARTIN, GEORGE H., Evanston, Ill.
MAY, ELWOOD R., Wilkes-Barre, Pa.
MCCALL, DESMOND, Pittsburg, Calif.
MEIER, WILLIAM G., Mason, Mich.
MEYER, C. A., Charlestown, W. Va.
MILLER, JOHN G., Reading, Pa.
NELSON, ROBERT P., Cabimas, Estado Zulia, Venezuela
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REGGEL, WALTER G. A., Huntington, W. Va.
RIED, ROBERT C., Carle Place, N. Y.
SHORT, M. K., Nebraska City, Neb.
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URECH, HENRY H., Houston, Texas
WELCH, A. WILLIAM, Dixfield, Me.
WELLS, ROBERT LESTER, Pa.
WULP, H. E. J., Detroit, Mich.
ZINK, J. JOSEPH, Silver Spring, Md.

Transfers from Student Member to Junior 90

Obituaries

Arthur Adelman (1879–1950?)

ARTHUR ADELMAN, whose death was recently reported to the Society, was chief engineer, American Division, Industrial Service Ordnance Department, U. S. A., Washington, D. C. Born, Norwalk, Ohio, Jan. 29, 1879. Parents, John P. and Margaret (Bishop) Adelman. Education BSME, Michigan State College, 1904. Married Nora E. Christian, 1906; children, Christian B. and Phyllis M. Mem. ASME, 1916. He was author of several technical papers; inventor of semiautomatic mechanisms for artillery guns; and held several patents on artillery fuses.

Frank Howard Cronin (1878–1949)

FRANK H. CRONIN, power consultant, National Vulcanized Fibre Co., Wilmington, Del., died at University of Pennsylvania Hospital, Philadelphia, Pa., July 29, 1949. Born, Aberdeen, Md., April 22, 1878. Parents, B. Frank and Lydia (Hopkins) Cronin. Education, BS, Armour Institute of Technology, 1903; ME, 1906.

(*ASME News continued on page 372*)

YOU CAN ALWAYS *trust* R-C METERS

R-C Meter installation for large gas utility. New unit, in front, has capacity of 1,000,000 cfh. Two older meters, in background, have been in use for years.

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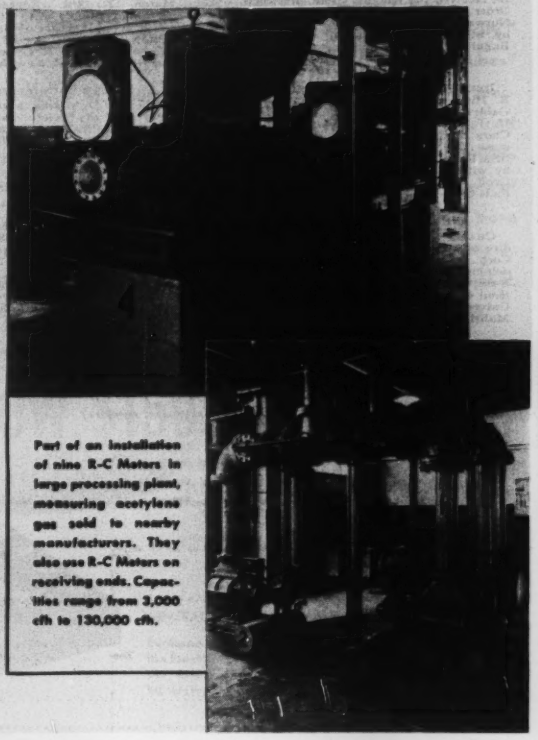

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Married Helen Fry. Mem. ASME, 1917. Survived by wife and son, John H., Newark, Del.

Leon Snell Dixon (1886–1950)

LEON S. DIXON, consulting engineer, Bangor, Me., died Dec. 11, 1950. Born, Medford Center, Me., June 13, 1886. Parents, Aston Clark and Mary (Snell) Dixon. Education, BSME, University of Maine, 1908. Married Florence E. Perkins, 1907; children, Alton Mills, Robert Alden. Married 2nd, Clarissa Danforth, 1934. Mem. ASME, 1921.

Ernest Mercer Fernald (1893–1951)

ERNEST M. FERNALD, professor, mechanical engineering, Lafayette College, died Jan. 22, 1951. Born, New York, N. Y., Oct. 7, 1893. Parents, Frederik A. and Natalie (Richmond) Fernald. Education, ME, Cornell University, 1915; MME, 1925. Married Matilda B. Atkinson, 1928. Author: "Elements of Thermodynamics"; technical articles. Jun. ASME, 1918; Mem. ASME, 1928.

Walter Geist (1894–1951)

WALTER GEIST, president, Allis-Chalmers Manufacturing Co., Milwaukee, Wis., died Jan 29, 1951. Born, Milwaukee, Wis., Dec. 1, 1894. Parents, Christian and Annette (Haagensen) Geist. Education, public schools; extension courses. Married Florence E. Koppernud, 1917. He invented and developed the multiple V-belt Texrope drive. He was the recipient of a Modern Pioneer Award, 1940; hon. LLD degrees, Marquette University; Lawrence College; hon. DE, Michigan College of Mining and Technology. He received the Knights Cross, first class, Royal Order of St. Olav, from King Haakon VIII of Norway, 1950. Mem. ASME, 1950. Survived by wife and two children, Mrs. Janet Lucille Bugni and Kenneth R.

John Edgar Hires (1885–1951)

JOHN E. HIRES, vice-president, The Charles E. Hires Co., Philadelphia, Pa., died in Coral Gables, Fla., Jan. 23, 1951. Born, Haddonfield, N. J., Feb. 8, 1885. Parents, Charles E. and Clara K. Hires. Education, three years' Swarthmore College. Married Thura Truax. Assoc. ASME, 1922; Mem. ASME, 1926. Survived by wife and three children, Mrs. Jacqueline H. Groff, Cynwyd, Pa.; Mrs. Thura H. Schock, Falls Church, Va.; C. Edgar Hires, Ardmore, Pa.

Charles Emil Joos (1896–1951)

CHARLES E. JOOS, senior vice-president, director, Cochrane Corp., Liquid Conditioning Corp., and Cochrane Engineering Corp., Philadelphia, Pa., died at Wyncote, Pa., Jan. 7, 1951. Born, Philadelphia, Pa., Nov. 4, 1896. Parents, Emil and Katherine Joos. Education, BSChE, University of Pennsylvania, 1920. Married Mabelle Martin. He was a recognized authority in the field of water treatment and was responsible for the development of many of the most effective methods of conditioning water for use in high-pressure boiler plants. Mem. ASME, 1941. Survived by wife and two children, Robert M. and Suzanne.

Harry James MacCamy (1887–1950)

HARRY J. MACCAMY, assistant manager and chief engineer, Union Iron Works, Spokane, Wash., died June 20, 1950. Born, Minneapolis, Minn., June 4, 1887. Parents, Harry James and Anna MacCamy. Education, high-school graduate; ICS. Married Frances B. Hollingsworth, 1910. Assoc-Mem. ASME, 1921; Mem. ASME, 1935. He served the Society as chairman, Inland Empire Section, 1928, 1929; member, Executive Committee of this section, 1931. Survived by wife and daughter, Eloise Lower, Spokane, Wash.

George McQuilkin, Jr. (1877–1950)

GEORGE MCQUILKIN, JR., retired consulting engineer, Merchantville, N. J., died Sept. 29, 1950. Born, Philadelphia, Pa., Feb. 2, 1877. Parents, George and Eliza Jane McQuilkin. Education, two certificates, Drexel Institute of Technology, 1897. Married Margherite Rathbone, 1908. Mem. ASME, 1944. Survived by wife and son, George, 3rd; Charlotte, N. C.

Wynn Meredith (1864–1950)

WYNN MEREDITH, a partner of Sanderson and Porter, New York, N. Y., who was in charge of the company's San Francisco (Calif.) office since 1908, died Dec. 21, 1950. Born, Big Rock, Ill., March 12, 1864. Education, attended University of Illinois. Married Ida Knowles. He was a noted inventor of electrical and hydraulic equipment. Mem. ASME, 1913. Survived by wife, a daughter, Mrs. George Harlowe, and a stepson, Gorham B. Knowles.

William Davis Moore (1882–1950)

WILLIAM D. MOORE, whose death was recently reported to the Society, was president, American Cast Iron Pipe Co., Birmingham, Ala. Born, Hannibal, Mo., April 17, 1882. Education, graduate, Galion (Ohio) High School. Mem. ASME, 1921.

Thomas Carlyle Morris (1886–1950)

THOMAS C. MORRIS, manager of engineering, Nitrogen Division, The Solvay Process Co., Hopewell, Va., died Dec. 25, 1950. Born, Bristol, Minn., Feb. 11, 1886. Parents, Evan O. and Ellen (Williams) Morris. Education, ME, University of Minnesota, 1908. Married Elizabeth Jones, 1921. Mem. ASME, 1918. Survived by wife, a son, Thomas G., Minneapolis, Minn., two daughters, Mrs. Betsy M. Zeugner, Chula Vista, Calif., and Judith L., Petersburg, Va., and a grandson.

Walter Herbert Pearson (1900–1951)

WALTER H. PEARSON, president and owner, W. H. Pearson and Son, consulting engineers, Wayne, Pa., died Jan. 6, 1951. Born, Plainfield, N. J., Oct. 23, 1900. Parents, Walter Herbert and Regina (Heinrich) Pearson. Education, attended Newark Tech.; The Franklin Institute. Married Lydia G. Gathman, 1924. Mem. ASME, 1946. Survived by wife and three children, Walter H., 3rd, Robert F., Ruth L. K.

Walter Rautenstrauch (1880–1951)

WALTER RAUTENSTRAUCH, professor emeritus, founder of Columbia University's department of industrial engineering which he headed until his retirement in 1945, died Jan. 3, 1951, in Lenox Hill Hospital, New York, N. Y. Born, Sedalia, Mo., Sept. 7, 1880. Parents, Julius and Anna (Nichter) Rautenstrauch. Education, BS, University of Missouri, 1902; LLD, 1932; MS, University of Maine, 1903; attended Cornell University, 1903–1904. Married Minerva Babb, 1904. Author: "Syllabus of Lectures on Machine Design," 1906; "Machine Drafting," 1908; "The Economics of Business Enterprise," 1939; "Who Gets the Money," 1939. He was also coauthor of several other books. He wrote many technical pamphlets and contributed papers to scientific journals. He was a central figure in the "Technocracy" movement of the fall of 1932. Jun. ASME, 1904; Mem. ASME, 1911. He served the Society on several committees and was chairman, ASME Research Committee, 1922; ASME representative on American Engineering Standards Committee (ASA) Sectional Committee on Standardization on Shafting, 1921–1924; chairman, ASME Metropolitan Section, 1911. Survived by wife and two sons, Prof. Robert F., Bucknell University, and Dr. Walter, Jr., Veterans Hospital, St. Petersburg, Fla.

Benjamin H. Spencer (1889–1950)

B. H. SPENCER, mechanical engineer, Sanderson and Porter, New York, N. Y., died Dec. 23, 1950. Born, Troy, Pa., Jan. 14, 1889. Parents, Edwin and Charlotte Spencer. Education, ME, Lehigh University, 1913. Married May Hobbs, 1914; children, Charlotte, Alice. Mem. ASME, 1927. Survived by wife and two daughters.

George Edward Swanson (1923–1950)

GEORGE E. SWANSON, design engineer, Aeronautical and Ordnance Division, General Electric Co., Schenectady, N. Y., died Oct. 11, 1950. Born, New York, N. Y., April 4, 1923. Parents, Edwin G. and Gerda (Bohm) Swanson. Education, BME, Pratt Institute, 1948. Married Nora Irene Winters, 1949. Jun. ASME, 1948. Survived by wife and son, Mark Edward.

Nathaniel Gardner Symonds (1878–1951)

NATHANIEL G. SYMONDS, consultant, Carl L. Norden, Inc., died Jan. 20, 1951. Born, Ossining, N. Y., Sept. 19, 1878. Parents, Henry Clay and Beatrice (Brandreth) Symonds. Education, BAEE, Stanford University, 1901. Married Amy Irene Millberry, 1901 (died 1942); children, Henry G., Houston, Texas, Nathaniel M., and Cortlandt, Chicago, Ill., Married 2nd, Gertrude Gutknecht, 1943. Jun. ASME, 1905; Mem. ASME, 1915.

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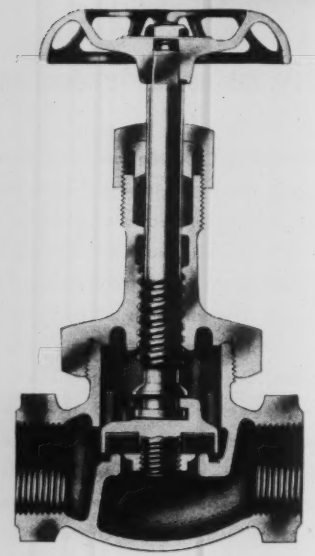

Fig. 506 Bronze Globe
400 lbs. O.W.G. ¼" to 2"

Fig. 507 Bronze Check
400 lbs. O.W.G. ¼" to 2"

Fig. 508 Bronze Angle
400 lbs. O.W.G. ¼" to 2"

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CATALOG GUIDE

1 SPREADER STOKERS

Standard Stoker Co., Inc.—New Bulletin No. 85 describes the application and construction features of the Chicago automatic spreader stoker which is designed to distribute coal most effectively over the entire grate surface and meet fully all firing requirements. Detail photographs and cross-sectional drawings illustrate operating features of the improved stoker.

2 CHAIN DRIVES

Morse Chain Co.—Catalog No. C55-50 covers immediately available sizes of roller chains and sprockets. Contains complete dimensions, list prices, and horsepower ratings. Types A, B, and C sprockets are listed. Engineering information on drive selection, calculation of chain lengths, lubrication, installation, and maintenance of roller chain drives.

3 HYDRAULIC "OIL" POWER EQUIPMENT

Vickers, Inc.—Bulletin No. 5000 contains general design information and specifications of a complete line of pumps, valves, controls, and related equipment for oil hydraulic power transmission in machine-tool and general industrial field. Individual units, also standardized or custom-built power units, transmissions, and control panels available.

4 STEEL BOILERS

Kewanee Boiler Corp.—Kewanee Steel Boilers. Lo and Hi Pressure Series. Welded and Riveted for mechanical or hand-firing and convertible. Steam radiation ratings 1380 to 42,500 sq ft commercial, 330 to 3000 sq ft residential sizes. Shown in 24-page General Catalog 80.

5 BALL BEARINGS

New Departure, Div. of General Motors—Supplementing its standard Catalog, a series of five books, helpful to the engineer and designer in applying ball bearings to any new machine. The first book deals with principal bearing types and fundamentals of mounting practice; the second, details of shaft and housing designs; and the third, enclosure and lubrication for varying operating conditions; the fourth book gives a new simplified method of computing bearing loads; while the fifth entitled, "Application Procedure," outlines the necessary steps in obtaining assured bearing performance.

6 CRUSHERS

American Pulverizer Co.—Bulletin illustrates and describes in detail complete line of custom-built crushers, grinders, shredders, and choppers for uniform reduction. Includes cutaway and cross-sectional views as well as engineering data and specifications.

7 FLEXIBLE COUPLINGS

Thomas Flexible Coupling Co.—The latest engineering information on Thomas Flexible Couplings is contained in their Engineering Catalog, which shows their complete lines of single and double types of all metal flexible couplings for heavy-duty impulse loads such as Diesel-driven compressors, as well as for smooth loads such as motor-driven centrifugal pumps.

8 FORGED STEEL VALVES, FITTINGS, AND FLANGES

Henry Vogt Machine Co.—New Catalog F-9 has 400 pages of new and improved forged-steel valves, fittings, and flanges for every modern piping requirement at high or low pressures and temperatures. A Refrigeration Section is included.

9 HYDRAULIC ELECTRIC POWER UNITS

American Blower Corp.—New Gyrol Fluid Drive Hydraulic Electric Power Units. "Power in a Package" pictorially described in Bulletin No. 8519. Bulletin mentions applications, shows illustrative test photographs, and includes ratings and dimensions.

10 FILTERS AND STRAINERS

Cuno Engineering Corp.—Completely revised Catalog of filters and strainers provides answer to nearly any fluid-conditioning problem. Contains complete specifications, including engineering drawings, for all standard models. Principles of construction and operation described and illustrated.

11 TUBING

Bundy Tubing Co.—New 20-page Booklet, in color, contains technical data and fabricating information on Bundyweld steel (copper or tin-coated) tubing of particular interest to production and design engineers in metal-working industries.

Continued on Page 46

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BUYER'S CATALOG GUIDE

12 FLAT LAPPING

Crane Packing Co.—12-page Booklet, fully describes new "Lapmaster" method of flat lapping to extremely close tolerances on an automatic high-production basis. Photographs, diagrammatic drawings, and complete data on "John Crane" Lapmaster Models "12" and "24" provide profitable information for all industries whose manufacturing operations include finishing parts to precision surface flatness and finish.

13 BITUMASTIC PROTECTIVE COATINGS

Koppers Company, Inc.—Informative package of six bulletins covers (1) Bitumastic Hi Heat gray for high-temperature corrosion prevention; (2) Bitumastic Black Solution for general, low-cost maintenance; (3) Bitumastic Super-Service Black, heavy-duty coating for more severe conditions; (4) Bitumastic No. 50, extra heavy-duty coating for extremely severe corrosive conditions; (5) Bitumastic No. 28, heavy-duty coating for atmospheric corrosion control; (6) Bitumastic Tank Solution, quick drying, useful for water tanks, air-conditioning equipment, etc.

14 MECHANICAL SPRINGS

Associated Spring Corp.—"The Mainspring," periodical of current thinking on spring-design news and applications. Semi-technical short articles in easy-to-follow style, with humorous illustrations. Covers all types of springs and other pertinent data. Issued every two months. Subscription free upon request.

15 STEAM BOILERS

Wickes Boiler Co.—Bulletins No. 44-1-2-3-4, 46-2, 48-1, 48-2, and 49-1 describe water-tube boilers of the 2-, 3-, and 4-drum design for direct firing by means of oil, pulverized coal or stokers; also waste-heat units, Dowtherm, and package-type water-tube boilers; Dowtherm Vaporizers; and Steam Generators. Boilers are built for pressures up to 850 psi and capacities to 250,000 lb of steam per hr.

16 ALL PURPOSE COPYING PROCESS

Ozalid, Div. of General Aniline & Film Corp.—4-page illustrated Folder briefly explaining the story of Ozalid—the modern, speedy way to copy anything typed, drawn, or written. Contains a graphic explanation of the process; complete machine specifications and descriptions; and a brief description of the type of sensitized materials available together with their recommended uses.

17 SIMPLEX (SINGLE BASKET) STRAINERS

Andale Co.—Bulletin No. 130-R1 (24 pages) contains information on strainers for working pressures from 125 psig; cast bodies of iron, bronze, and steel; dimensions of strainers; dimensions of baskets; free areas of mesh and perforated sheet baskets; pressure-loss charts; corrections for viscosity, fouling, and basket mesh; applications.

18 COAL-HANDLING EQUIPMENT

Gifford-Wood Co.—24-page Bulletin No. 300 describes the Gifford Wood "4 Basic Types" of coal-handling installations, namely, concrete silo, tile silo, cylindrical steel tank, and suspended steel bunker. Contains illustrations and working drawings of all four types of installations in many industries. Auxiliary equipment for coal and ash handling is also shown.

19 CLUTCHES AND POWER TAKE-OFFS

Rockford Clutch Div., Borg-Warner Corp.—Bulletin on Power Transmission Control shows typical installation of Rockford Clutches and Power Take-Offs. Contains diagrams of unique applications. Furnishes capacity tables, dimensions, and complete specifications. Every production engineer will find help in this handy bulletin when planning his new products.

20 BRONZE CASTING ALLOYS

American Manganese Bronze Co.—50-page Edition of the "Reference Book on Bronze Casting Alloys" gives general information on composition, characteristics, and applications of many of the common or typical alloys. The Book will help the engineer or designer in the selection of the right alloys for any general application.

21 THERMOSTATIC STEAM TRAPS

Sarco Co.—Stainless-steel and monel elements for pressures to 300 psi and for corrosive condensate are a feature of the new line of Sarco thermostatic steam traps. Condensate and air venting capacities of all traps are practically doubled, through a new design which permits traps to reach rated capacities with a drop from steam temperature of only 10 F. New Bulletin 250-A.

22 LUBRICATION

Lubriplate Div., Fiske Bros. Refining Co.—Announces the release of a new 56-page Lubriplate Data Book 1-50 which contains some very valuable information on the subject of lubrication.

23 ROLLER CHAIN FLEXIBLE COUPLINGS

Baldwin-Duckworth Div., Chain Belt Co.—New illustrated 12-Page Catalog gives complete data on roller chain couplings and how to select them, and on coupling covers and their advantages. Also contains specification data with many tables and charts on permissible angular and radial misalignments, tables on bore tolerances, etc.

24 DRAFTING ROOM EQUIPMENT

Hamilton Manufacturing Co.—Drafting equipment is described in Hamilton Catalog No. 13-S. Auto-Shift tables with instant adjustment for height and slant from horizontal to vertical; tracing files with patented tracing lifter, making every sheet a top sheet; and a complete line of files and drawing tables to meet all requirements.

25 PYROMETERS

Leeds & Northrup Co.—Micromax instruments for measuring, recording, and controlling temperatures detected by thermocouples are described in Catalog N-33A. Temperature instruments for use with Rayotubes are described in Catalog N-33B. For information on high-speed Speedomax Recorders for industrial temperatures, see Catalog ND46. Complete equipment for checking thermocouple pyrometers is listed in Catalog E-33A-503.

26 MARINE BOILERS AND STOKERS

James Leffel & Co.—New 28-page Bulletin No. 236, describes 6-hp to 250-hp Leffel Scotch Marine Boilers and Underfeed Stokers. Photos and cut-away drawings show design and application details. Test results, case studies, and specification data are included. The Leffel automatic underfeed stoker which is also suitable for other makes of Scotch-type boilers is described.

Continued on Page 48

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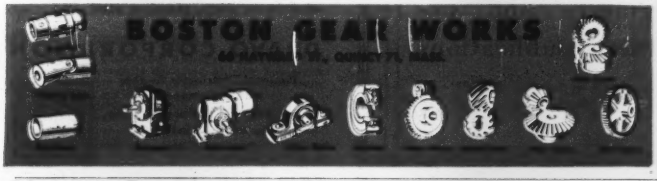

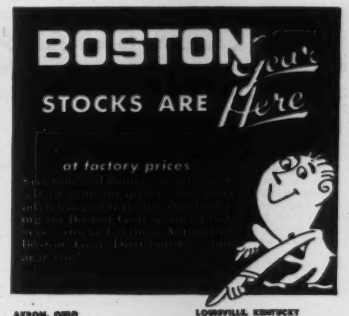

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27 TEMPERATURE CONTROLLERS

Foxboro Co.—Bulletin No. 225 presents in 40 illustrated pages the pneumatic temperature controllers included in the extensive line of Foxboro Instruments, pneumatic, electric, and electronic. Other bulletins cover such individual subjects as indicating, recording, and controlling instruments of various types, or instrumentation for specific applications. Correspondence is invited on any phase of instrument engineering involving temperature, pressure, flow, liquid level, humidity, pH, density, conductivity, speed, weight and force, etc., control valves, instrument panels, or complete control systems.

28 AIR PREHEATERS

Air Preheater Corp.—First section of Catalog on Ljungstrom Air Preheaters presents an over-all picture of the Ljungstrom, its functions, and operation. Examples of installations of the Ljungstrom continuous counterflow regenerative-type preheater, covering a range of diverse applications, are shown in diagrammatic form, together with photographs of the Ljungstrom in sufficient detail to make its principle and operation clear.

29 TRAPS FOR REMOVING WATER FROM COMPRESSED AIR

Armstrong Machine Works—Bulletin 2021 deals with three types of traps for removing water from compressed air. This 4-page bulletin explains the advantages and limitations of each type of trap and contains specific recommendations on traps for handling water contaminated with heavy oil and sludge; small amounts of clean water from high-pressure air lines; and draining receivers, separators, and aftercoolers.

30 SILICONE PRODUCTS

Dow Corning Corp.—A Reference Guide to Dow Corning Silicone Products is a new general catalog which lists over 50 different Dow Corning Silicones according to their physical form and applications. Important properties of each product and code numbers for obtaining more information about any particular product are conveniently presented in this 4-page bulletin.

31 UNFIRED PRESSURE VESSELS

Downingtown Iron Works—A partial analysis of the 1950 ASME Code for Unfired Pressure Vessels compared with the 1949 Code has been prepared by the Downingtown Iron Works. In addition to the comparison there are data on the facilities and manufacturing equipment and the welding procedure qualifications of the Downingtown organization.

32 AIR-COOLED ENGINES

Wisconsin Motor Corp.—56-page delux Catalog, printed 2 colors, illustrating and describing factory production processes of engines in detail. Contains 146 illustrations and captions covering a great variety of engine power applications in many fields; illustrations of full line of engines, 2 to 30 hp; with brief specifications, general data, and list of Wisconsin distributors by states.

33 OIL SEALS

Johns-Manville—Clipper Seal Brochure describes complete story of this precision-molded oil seal that provides efficient bearing protection at low cost. Includes photographs and diagrams of typical installations; shows how various lip designs provide choice of bearing surfaces; how its simple one-piece construction allows greater freedom in designing oil-seal cavities.

34 CONVEYOR ROLL BEARINGS

Marlin-Rockwell Corp.—M-R-C Conveyor Roll Bearing Bulletin (Form 1529) is a 4-page, 8½ × 11-in. illustrated folder on M-R-C CONV-3-SF and CONV-4-SF ball bearings. These bearings are specially designed for use on conveyor rolls, and have four important features, resulting in reduced machining operations, cheaper mounting costs, reduced belting cost, and improved belt alignment.

35 SPUN END PROCESS

Wolverine Tube Div., Calumet & Hecla Cons. Copper Co.—Brochure describes the distinctive Spun End Process. In 28 pages it tells a concise story of a revolutionary metal-forming process that is highly efficient and relatively inexpensive. A quick com-

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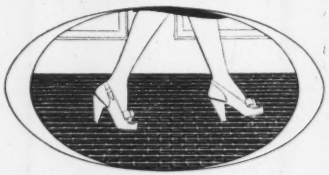

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36 FELTS

American Felt Co.—Special SAE Folder contains technical data and specifications of the various felts made to SAE standards. The folder includes illustrative samples.

37 PIPE AND TUBES

National Tube Co., Tubing Specialties Div.—Bulletin 26 presents technical data on 25 alloy steels suitable for high-pressure high-temperature service. Includes many tubular products manufactured in accordance with ASME Boiler Code specifications. Relative cost figures aid in selecting best alloy for special service.

38 VIBRATION FATIGUE TESTER WITH THYMOTROL DRIVE

All American Tool & Mfg. Co.—Catalog page 100 HA-T describes vibration fatigue tester which provides smooth, stepless acceleration from 10 to 100 cps by means of G-E Thymotrol electronic drive. Parts up to 100 lb in weight can be tested. Table movement is horizontal. Maximum capacity is 23 *g*.

39 MECHANICAL DRIVE TURBINES

General Electric Co.—Bulletin GEA-4955A, "A New Standard In Mechanical Drive Turbines," describes G-E's new Type DP line of turbines in 19 pages and 21 illustrations. Designed to drive pumps, fans, compressors, blowers, and similar equipment, these turbines utilize pressure lubrication, balanced valve design, and nonsparking emergency governors. Ratings range from 10 to 1200-hp and 1000 to 5000 rpm.

40 UNIT HEATERS

Grinnell Co.—Catalog UH-1950 illustrates and describes horizontal and vertical delivery and Textile types of Grinnell Thermoliers. Textile type self-cleaning for use in dusty, lint, and fly-laden atmospheres. Complete capacities, dimensions, weights, motors, wiring diagrams, piping connections, and methods of suspension. Exclusive features described and illustrated.

41 DOWTHERM VAPORIZERS

Union Iron Works—Union offers a helpful bulletin for users, or potential users, of Dowtherm "A" or "E." Tables of chemical and physical characteristics are included, as well as pertinent dimensions of several sizes of Dowtherm vaporizers. Union engineering, manufacturing, and installation service covers a wide range of sizes and types of Dowtherm systems.

42 IRON CEMENTS

Smooth-On Manufacturing Co.—40-page, pocket size Smooth-On Repair Handbook describes practical, time-saving, money-saving metal repairs made on plant, shop, factory, garage, and home equipment with Smooth-On Iron Cements. Leaks stopped, cracks sealed, loose parts, and fixtures tightened. More than a million copies of this popular Manual have already been sent out in response to requests. Contains 170 diagrams. Clear tested directions.

43 MINIATURE BALL BEARINGS

Miniature Precision Bearings, Inc.—New 12-page Catalog, illustrated with comprehensive specifications on more than 70 types and sizes of standard miniature ball bearings from $1^1/_2$ mm to $^3/_8$ in. OD. Includes material of paticular interest to designers of precision mechanisms—applications, lubrication, design variations, special bearings, etc.

44 FOAM RUBBER, SPONGE RUBBER

Sponge Rubber Products Co.—New 12-page Folder illustrates shapes and forms, into which cellular rubber can be molded or die cut—tubing, cord, strips, sheets, rolls, pads. Describes typical applications in sealing, insulating, gasketing, dust proofing, weather stripping, sound deadening, shock absorption. Offers experimental examples.

45 HIGH PRESSURE PUMPS

Aldrich Pump Co.—New Aldrich Data Sheet 64-B describes the recently designed Aldrich 5-in-stroke Multiplex Direct Flow Pumps. This 6-page bulletin covers design advantages, construction, specifications, and drive requirements. Also included are a pump selection chart; dimension drawings; plunger, pressure, and capacity data on both the 5 and 7-plunger units.

Continued on Page 50

Let's Make the Most of Our Productive Might

THE productive might that has given America the most fruitful peace-time economy in history—the productive might that has backed to a victorious limit in two twentieth-century wars the fighting men who inevitably are our first line of defense—is facing an even greater test. It must not—it cannot be wasted!

The era of fighting and winning wars, and settling back during interims to "business as usual," is past. When it passed, how it passed, doesn't matter. What does matter is that from here on in, perhaps, there'll be no more "indolent" years—no more building of bathtubs to the exclusion of battleships; no more butter at the expense of bombs.

But America's unmatched productive might is fully capable of building bathtubs *and* battleships, of providing butter *and* the bombs requisite to war or to prevention of war; capable, that is, if properly employed—if none of it is wasted.

More And Better Tools Needed

THIS means that the manpower and womanpower left to industry after military needs have been satisfied, must be given every cost-cutting tool, every time-, labor- and muscle-saving aid known to man. It means that these tools must be employed intelligently and efficiently.

At the Fourth National Materials Handling Exposition,* to be held in the International Amphitheater in Chicago, April 30—May 4, 1951, the CLARK EQUIPMENT COMPANY'S INDUSTRIAL TRUCK DIVISION, along with several hundred other producers of materials-handling equipment, will show to industry the newest, the most efficient and the most effective tools in the world for *making the most of America's productive might*. It is a show that no industrial executive can afford to miss—it is the MUST of the Industrial Show year. It is a MUST not only from the point of economy and profits within your own operation—but also from the point of *accomplishing the vast production necessary to the new Military Economy without imposing harsh austerity on the Civilian Economy.*

More Power For Manpower—In Action

CLARK will show and demonstrate its full LEADERSHIP LINE of fork-lift trucks, powered hand trucks and industrial towing tractors. Among them will be several machines never before shown—some of them not yet in production. The exhibit also will present special handling attachments of proved worth, and demonstrations of their rich usefulness.

By all means attend and study this tremendously important show. And make a special point of seeing the CLARK exhibits and demonstrations of the best machines in their field for giving MORE POWER to MANPOWER.

*(*We'll be glad to supply registration—admission tickets. Just address your request to the Clark Equipment Co., Industrial Truck Division, Battle Creek 88, Michigan, telling us how many you want.)*

• DIRECT HEATING OF VAPORS

• DIRECT HEATING OF LIQUIDS

• DOWTHERM INDIRECT HEATING

If your plant requires

• STEAM GENERATORS

• STEAM SUPERHEATERS

• WASTE HEAT BOILERS

. . . place the selection of the specific type in specialized hands . . . and obtain optimum efficiency.

Petro-Chem Development Company engineers are heating specialists . . . they can supply the whys and wherefores of indirect versus direct heating and the economics of both.

Every day more than 750, oil and gas fired, Petro-Chem Iso-Flow installations in the petroleum, chemical and allied industries, demonstrate the efficiency of their design and installation.

PETRO-CHEM DEVELOPMENT CO., INC.
120 East 41st Street, New York 17, N. Y.

Representatives:

Bethlehem Supply, Tulsa and Houston • Flagg, Brackett & Durgin, Boston • D. D. Foster, Pittsburgh
Faville-Levally, Chicago • Lester Oberholtz, Calif.

INFORMATION SERVICE

46 DIRECT, POSITIVE COPIES

Charles Bruning Co.—"How to Duplicate Anything Drawn, Written, Typed or Printed" is a 48-page Brochure answering questions on the Bruning BW Copying Process. This interesting booklet describes the various uses and low cost of BW prints. Several case histories in various fields of industry illustrate the versatility of the clean and odorless BW Process.

47 TECHNICAL BOOKS

John Wiley & Sons—Publishers of scientific and technical books. 1951 Catalog available, containing descriptions of over 1300 books in science and engineering. Of particular interest to engineers are the following recently published Wiley titles: Kent's "Mechanical Engineers' Handbook," 12th edition—Power volume, edited by Salisbury—Design and Production volume, edited by Carmichael; Hetenyi's "Handbook of Experimental Stress Analysis," Salisbury's "Steam Turbines and Their Cycles," Eckman's "Industrial Instrumentation," and Brown's "Unit Operations."

48 GRATING—FLOORING, SAFETY TREADS

Irving Subway Grating Co.—Catalog No. F-225 contains illustrations, descriptions, and engineering data on fireproof, durable, safe, clean, and economical Gratings and Safety Steps (riveted, pressure-locked, and welded) for Industrial Plants, Power Plants, Refineries, Ships, Railroad Freight and Passenger Cars, and Locomotives, Open Steel-Mesh Bridge Decking, etc.

49 SEAMLESS WELDING FITTINGS AND FORGED STEEL FLANGES

Tube Turns, Inc.—Chart of Pipe and Fittings Materials. Quick-reference chart covering ASTM and other specifications, chemistry, service temperature limits and welding data on carbon, intermediate alloy, stainless and special analysis steels, dimensional data and weights. Folder of man-size tables giving dimensional information on Tube-Turn welding fittings from ½ to 30 in. in standard weight and extra strong, and flanges in all sizes and weights. Allowable working pressures. Booklet of pressure tables covering complete line Tube-Turn welding fittings for power piping, oil piping, heating piping, gas piping, refrigeration piping.

50 STEAM GENERATORS

Erie City Iron Works—Bulletin SB-38 describes the Erie City Keystone Steam Generator—a 2-drum water-tube boiler, steel-cased, insulated, and fired by automatic burner for oil or gas or both interchangeably. A complete unit in every detail in sizes from 75 to 800 hp for pressures from 160 psi.

51 HAND TRUCKS

Standard Pressed Steel Co.—Its new "Hallowell" Uni-Truk has unique, triple-welded angle construction of the nose, which eliminates danger of ends of side bars tearing loose. The Uni-Truk is inexpensive, lightweight, and well-balanced for nimble handling of all but the heaviest hand-truck jobs. Details contained in attractive, new illustrated Bulletin No. 789.

52 BLAST CLEANING AND DUST CONTROL

Pangborn Corp.—The latest developments in blast cleaning or dust control in Bulletin 1200, Pangborn's "Condensed Catalog." This illustrated bulletin tells the full story of air and airless blast cleaning, hydro-sand blast, hydro-finish, wet sand blast, accessories, and dust control.

53 O-RINGS

Linear, Inc.—Compact 6-page Folder contains tables of standard O-ring sizes as well as dimensional data for installation. Notes give general recommendations on clearances, design, material, machining, and finishes for most O-ring applications. A special compound bulletin containing descriptions of the latest polymers and synthetic rubbers from which O-rings can be molded is also included.

54 ROTARY OIL PUMPS

De Laval Steam Turbine Co.—The De Laval Catalog L313A-B describes the new IMO series A313A pump. This is designed for pumping petroleum products and other light or viscous fluids, against medium pressures, as required for rotary and steam atomizing oil burners, oil transfer, lubrication, hydraulic systems and similar services. Capacities to 85 gpm—pressure 150 psi.

55 RIGHT-ANGLE VERTICAL-PUMP DRIVES

Western Gear Works—Bulletin 4907 describes the Pacific Western line of right-angle vertical-pump drives which cover a wide range of power and speed

requirements, including all sizes larger than 200 hp at 1:1 ratio and 720 rpm. They are designed for 24 hr a day continuous duty in pumping service for the specific application of horizontal-type prime movers to vertical shaft pumps.

56 BROACHING MACHINES, PRESSES

Oilgear Co.—Bulletin No. 10052, contains complete specifications and condensed information on their standard line of Fluid Power Broaching Machines and Presses, illustrates and describes diversified special machines, and lists the fluid power components manufactured for direct and resale purposes.

57 PUMPS

Aurora Pump Co.—Condensed Catalog M, embodying illustrations, suggested uses, specifications, and condensed selection tables for Aurora Centrifugal and Apco Turbine-Type Pumps and Water Systems.

58 BALL BEARING SWIVEL JOINTS

Chiksan Co.—Catalog No. 50R illustrates and describes complete line of over 500 different types, styles, and sizes, with data on working pressures, maximum temperatures, dimensions, and weights. 12-page Catalog No. 2A gives data on Aircraft-Hydraulic Swivel Joints for pressures from 1000 psi to 3000 psi.

59 RECORDING MECHANICAL COUNTERS

Streeter-Amet Co.—New illustrated Bulletin on latest recording mechanical counters actuated by electrical impulses. Many new uses for these recording counters are depicted for industry as well as for science. Machine shops, airports, hospitals, scientific laboratories are among the wide range of fields where they can be used with profit. Variable components multiply the recording possibilities for a variety of counting and timing jobs.

60 MARINE PROPULSION UNITS

Western Gear Works—Bulletin No. 5070 describes the Pacific-Western line of marine planetary propulsion gears for engines developing over 600 hp, and extending as high as 50,000 hp in a single unit. Any reduction can be supplied. For ratios between 1.7 to 1 and 2.3 to 1, the spiral bevel type planetary unit is provided; for other ratios the helical gear is supplied. Bulletin outlines space and weight saving advantages of this highly efficient type of gearing.

61 WATER TUBE BOILERS

Babcock & Wilcox Co.—Bulletin G-72 describes the Integral-Furnace Boiler Type FM, a completely shop-assembled boiler for unit shipment, available in standard sizes for load ranges from 7000 to 25,000 lb of steam per hr at pressures up to 250 psi. Details of design, construction, installation, and operation are discussed and illustrated.

62 WATER CONDITIONING

Permutit Co.—Latest Development—Effluent from Hot Lime Soda Softener Reduced to Zero Hardness by Permutit Hot Zeolite Process No. 3507. The hot zeolite process which replaced second-stage phosphate treatment is described and illustrated.

63 ANACONDA COPPER AND COPPER ALLOYS

American Brass Co.—New edition of Anaconda Data Book contains 138 pages of tabulated weights and standard dimensions of copper and brass mill products, as well as compositions, physical constants, and properties of copper alloys. Miscellaneous data tables include conversions, comparisons of standard gages, capacities of tanks, dimensons of circles and squares, and mathematical rules and formulas.

64 STEEL OVERHEAD-TYPE DOORS

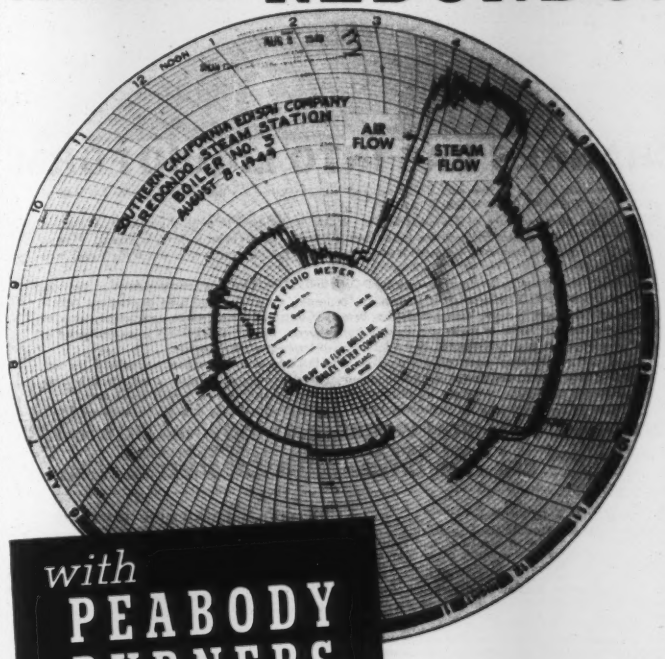
Kinnear Mfg. Co.—New 16-page Bulletin No. 68 describes galvanized steel sectional overhead-type door that combines durability with operating convenience and facilities for glass light sections for all types of commercial and industrial service openings. Gives details, clearance requirements, and available accessories.

65 AUTOMATIC CONTROLS

Mercoid Corp.—A complete line of automatic controls and mercury switches are illustrated and described in Mercoid Catalog No. 700. These electrically operated controls cover a wide range of applications involving the automatic control of pressure, temperature, liquid level, and for lever arm mechanical operations. Various types of mercury switches are made in numerous circuits.

Continued on Page 52

20 TO 1 RANGE AT REDONDO!



with PEABODY BURNERS *first choice of America's leading utilities...*

The Redondo Steam Station, like all the other plants of the Southern California Edison Company, is known for its modern engineering and efficient operation. The management of this leading public utility insists upon efficient combustion and steam generation — and they use PEABODY BURNERS to get results! The 42 burners in the Redondo Steam Station generate 3,080,000 lbs. of steam per hour and they are only a part of the 387 PEABODY BURNERS used by Southern California Edison Company in their system to generate over 8,000,000 pounds of steam per hour. For full details on PEABODY BURNERS *write for Bulletins 803 and 903.*

519

OFFICES IN PRINCIPAL CITIES

PEABODY ENGINEERING CORPORATION
580 FIFTH AVENUE • NEW YORK 19, N. Y.
Manufacturers of all types of combustion equipment, direct-fired air heaters, gas scrubbers, coolers, and absorbers

PEABODY LIMITED • LONDON, S.W. 15, ENGLAND

This STAINLESS STEEL CONDENSER

CHANGES GAS INTO LIQUID FORM

The condenser shown above was designed and manufactured by the Heat Transfer Division of DOWNINGTOWN IRON WORKS, INC.

Shell, tubes and ends are of Stainless Steel. Water is pumped through the shell and around the tubes . . . gas passes through the tubes and is thereby condensed to form a liquid. (Tubes have been omitted from four holes so that you may see the serrations into which the tubes are expanded.)

Many, many units similar to this are made by DOWNINGTOWN for domestic and foreign service. We of DOWNINGTOWN solicit your inquiry for heavy duty shell and tube equipment fabricated of Aluminum, Inconel, Nickel, Phosphor Bronze, Copper, Silicon Bronze and various grades of Carbon Steel. Some of these are welded by Heliarc. DOWNINGTOWN is experienced in building equipment with Bimetallic, Finned Tube and Impregnated Graphite.

Design and construction meet requirements of ASME Code or other agency specified by customer. Equipment of our design is sold on a guaranteed performance basis or we will fabricate to customer's drawings. Modern facilities available for radiographing where required.

Write on your letterhead for DOWNINGTOWN literature on shell and tube heat exchangers.

DOWNINGTOWN IRON WORKS, INC. DOWNINGTOWN, PA.

STEEL & ALLOY PLATE FABRICATION, HEAT EXCHANGERS

NEW YORK OFFICE—30 CHURCH STREET

CATALOGS

66 FACILITIES AND PRODUCTS

Newport News Shipbuilding & Dry Dock Co.—40-page Bulletin contains illustrations and information on the facilities and products other than shipbuilding of the Newport News company. Steel fabrication, subassembly methods, sheetmetal facilities, machine shops, forging, and foundries are featured in the publication.

67 INDUCTION HEATING

Ohio Crankshaft Co., Tocco Div.—New Catalog 22, 20 pages, describes the principles, applications, and equipment of Tocco induction heating. Typical results of induction hardening and heat-treating, and results of induction heating for forming and forging are given.

68 MATERIAL-HANDLING TRUCKS

Colson Corp.—New Catalog No. L-292-R describes the many Colson hand trucks available for easy handling of a variety of shapes. Included are the "lift jack" system for moving heavy loads at half the cost; trucks to handle products and materials of every description; hampers, instrument tables, stretchers, tray, and oxygen tank trucks.

69 PILOTED TYPE COUPLINGS

Falk Corp.—Bulletin No. 4115 gives construction features, dimensions, typical applications, tables, and specifications, of Type P Falk Piloted Steelflax Couplings.

70 OIL BURNERS—HEAVY DUTY

S. T. Johnson Co.—Data sheets give performance data, specifications, illustrations, and engineering drawings on Johnson's heavy-duty industrial oil burners and combination oil and gas burners, designed for steam, hot-water, or radiant-heating installations in hotels, hospitals, factories, public buildings.

71 REPRODUCTION MATERIALS FOR ENGINEERING

Eastman Kodak Co.—A line of photographic materials for engineering drawing reproduction is described in a new Booklet, "Modern Drawing and Document Reproduction with Kodagraph Reproduction Materials." Of particular interest to engineers are three direct-to-positive printing room-light-handling materials . . . Kodagraph Autopositive Paper, Kodagraph Autopositive Film, and Kodagraph Autopositive Cloth, which have valuable applications for making intermediates. They can be exposed with conventional drafting-room equipment. Also described are Kodagraph Contact Paper and Kodagraph Projection Papers, as well as Kodagraph Contact and Projection Cloths, which meet additional requirements of drafting rooms and reproduction departments.

72 HYDRAULIC PUMPS AND CONTROLS

Denison Engineering Co.—New illustrated Bulletin No. 138 describes the Denison line of HydrOILic pumps, motors, 4-way valves, relief and sequence valves, and hydraulic pumping units for circuits for pressures up to 5000 psi. New surge damping control valve and pilot-operated solenoid control for preventing spool sticking is included.

73 PRESSURE GAGES

Helicoid Gage Div., American Chain & Cable Co.—New 16-page Helicoid Gage Catalog. The Helicoid Gage is the only pressure gage with the Helicoid movement. It is guaranteed accurate to within ½ of 1 per cent of the total dial graduation over the upper 95 per cent of the 280 deg dial arc. This means that on a 100-lb dial for example, accuracy is guaranteed to within ½ lb over the entire scale except from 0 to 5 lb. Cutaway photographs and line drawings show the complete line of Helicoid Gages.

74 SLITTERS AND SLITTING LINES

Yoder Co.—Basic information on design, selection, and operation of slitters and slitting lines; time studies and analysis of operating cycle; and coil handling and scrap-disposal methods, are presented in 74-page Catalog. Specifications, capacity tables, and other data on Yoder standardized series of uncoilers, slitters, recoilers, coil cars, and scrap choppers are given.

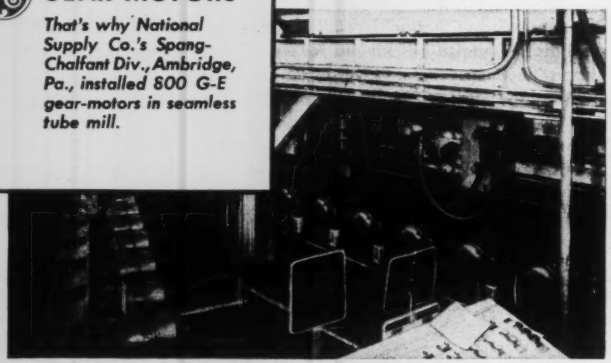
75 PROTECTIVE COATINGS

Insul-Mastic Corp. of America—Booklet describes Insul-Mastic protective coatings and methods of application that now make available, in one applica-

HIGH-SPEED SOLUTIONS TO.....

GEAR-MOTORS

That's why National Supply Co.'s Spang-Chalfant Div., Ambridge, Pa., installed 800 G-E gear-motors in seamless tube mill.



On billet-heating operation, 60 compact G-E gear-motors save much-needed space formerly taken up by line shafts and gears. Automatic control of the 1-hp gear-motors boosted production and turned out better products.

One gear-motor for each driving roller eliminates excess maintenance costs and hazards of former line shafts and separate, unprotected gears.

tion operation, coverings 10 to 30 times as thick as coatings of conventional paint. Composition, properties, and method of application, are included.

76 STEEL CASTINGS

Continental Foundry & Machine Co.—Twelve basic considerations which should govern the selection of a supplier of steel castings—and other industrial suppliers as well—are reviewed in new 32-page brochure.

77 RECORDING OSCILLOGRAPHS

Consolidated Engineering Corp.—Two new 12-page Bulletins discuss applications, operations, and features of multichannel recording oscillographs. Sample records of actual applications are presented along with detailed assembly drawings. Technical information and response curves of Consolidated Galvanometers are included. Accessories, associated equipment, and the Customer Service Plan are described.

78 PLUG VALVES

Kerotest Manufacturing Co.—Bulletin No. TS-50 describes a new nonlubricated plug valve, called Kerotest General Twin Seal Valve, for operation in normal to subzero temperatures, on all types of gaseous and volatile liquid service.

79 FAFNIR FLANGETTE

Fafnir Bearing Co.—6-page Folder describes a complete power Transmission Unit, incorporating a Fafnir Wide Inner Ring Ball Bearing, and Self-Locking Collar. Housings are interchangeable steel flanges with inside surfaces matching bearing outer ring, thus providing initial self-alignment in all directions. Folder carries photos, installation instructions, sizes, and load ratings.

80 LUBRICATION

The Brooks Oil Co.—New 24-page brochure, commemorating the company's 75th anniversary, combines both technical data and historical information about the company. Included in the technical section are details on lubricants, such as Leadolene, Klingfast, and Roll Oil F.

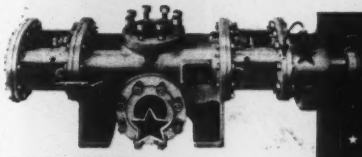
81 STEEL FLOORING AND ARMORING

Dravo Corp.—Machinery Div.—Catalog No. 1103 describes various types of open-steel flooring and armoring and discusses different types of Tri-Lok open-steel flooring and safety treads. Specification data, safe-load tables, installation methods, and other pertinent information, are included.

82 FLY-ASH COLLECTION

Research Corp.—Bulletin No. FA, entitled "What's New in Fly Ash Collection," discusses problem, particle-size analysis, efficiencies, new developments, and engineering features of Research Corp. electrical precipitators for this service. Continuous rapping and automatic voltage control equipment described.

NEW Sier-Bath SCREW PUMP
for NON-LUBRICATING LIQUIDS



External Gear & Bearing Bracket Type with *New*

★★ "Dual-controlled" ROTORS

★ Single-point ALIGNMENT

Capacities: 1-700 GPM

Discharge: 1000 PSI for viscous liquids
250 PSI for water

USED to move your non-lubricating fluids or semi-fluids, this powerful new screw pump will give you greater dependability, longer life, and cost you less to service and maintain. For less wear on bearings and timing gears, its rotors are "dual-controlled"—*axially* by heavy-duty thrust bearings, and *radially* by precision cut timing gears and heavy duty roller bearings.

To eliminate the possibility of bearing strain and rotor misalignment, the gear and bearing housings now form an integral unit with the pump body. Thus they move *with* the pump body if it is slightly displaced during installation, or if it expands when handling hot liquids.

Servicing is speeded by the new bracket arrangement. The rotor shafts are clearly marked for accurate positioning of parts, and all parts are automatically positioned by shoulders and locknuts.

Direct-connected up to 1800 RPM. Available in horizontal or vertical construction, corrosion resistant alloys. Special bodies, stuffing boxes and bearings for high temperature applications.

WRITE FOR FURTHER INFORMATION

9270 HUDSON BLVD.
N. BERGEN, N. J.

Sier-Bath
GEAR and PUMP CO., Inc.

Founded 1905 Members A.G.M.A.

83 GEARS, ETC.

Boston Gear Works—Catalog No. 55 gives complete information and prices on over 4500 stock items including spur, miter, bevel, helical, and worm gears, roller chains, sprockets, ball bearings, pillow blocks, couplings, pulleys, speed reducers, ratiomotors, and oil-impregnated porous bronze bearings. It provides engineering data, formulas, horsepower rating charts, reference tables, and selection charts for figuring the correct power drive and selecting the proper equipment for virtually every mechanical power transmission.

84 OIL BURNERS

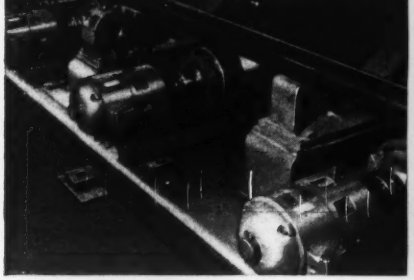
Engineer Co.—New Bulletin OB-PC describes wide range mechanical or steam-atomizing-type oil atomizers for all types of pulverized coal; gas or oil-burning air registers; and fuel-oil pumping and heating-unit systems.

85 REDUCING VALVES

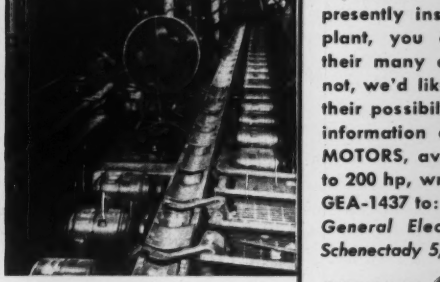
Golden-Anderson Valve Specialty Co.—Bulletin No. W-3 features general arrangement of the Golden-Anderson cushioned water-pressure reducing valve and the reducing pilot valve, with a detailed list of parts. Installation, operation, adjustment, servicing, and specifications are fully described. Tables give general dimensions, approximate shipping weights, and general list of materials

Continued on Page 54

LOW-SPEED PROBLEMS — G-E GEAR-MOTORS



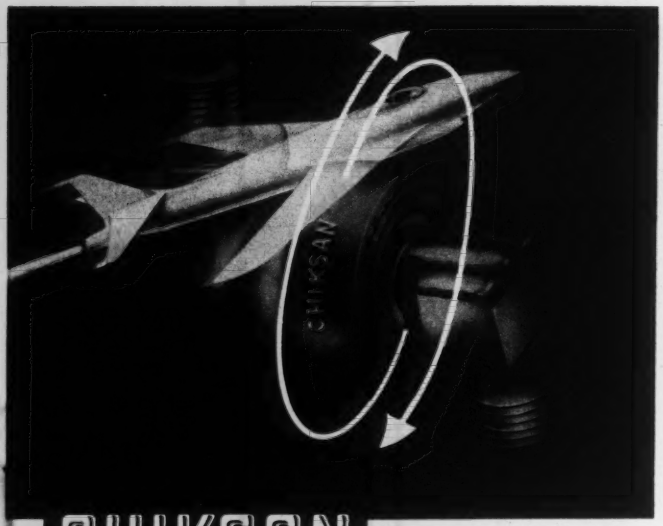
Automatic operation reduced labor costs. Dependability of G-E gear-motors lessened breakdowns. Standardization of motors minimized stocking of spare parts.



As a result, National Supply has installed more than 800 G-E gear-motors for their low-speed drives.

If you have G-E gear-motors presently installed in your plant, you already know their many advantages. If not, we'd like to show you their possibilities. For more information on G-E GEAR-MOTORS, available from 1 to 200 hp, write for bulletin GEA-1437 to: *Section C755-6, General Electric Company, Schenectady 5, New York.*

GENERAL ELECTRIC



CHIKSAN

STANDARD APPLICATIONS FOR CHIKSAN AIRCRAFT SWIVEL JOINTS
FUEL DUMP CHUTES • WING FOLD • FLIGHT CONTROL • OXYGEN LINES • HYDRAULIC LINES, LANDING GEAR • FUEL AND OIL TANK SWING INTAKES

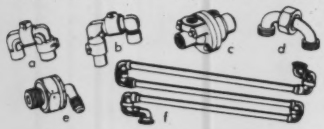
....a great name at MACH 1

No need to waste precious time... and money... on design, mock-up and testing to develop Swivel Joints for your flexible lines. CHIKSAN *Ball-Bearing* Swivel Joints are proved *now* for all kinds of applications.

With CHIKSAN Swivel Joints, you can build flexible lines with all-metal tubing which permit tight bends and fit into limited space... lines which permit unlimited flexibility without drag or sag... lines which assure maximum safety and dependability under pressures to 3,000 psi. (to 15,000 psi. on industrial applications).

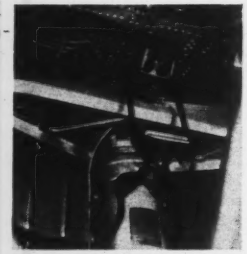
CHIKSAN performance is proved by the continued acceptance of leading Aircraft and Industrial manufacturers for applications in civilian and military equipment for use on land, on the sea and in the air.

(a) Basic Type Swivel Joints – for pressures from 125 psi. to 15,000 psi. (b) High Temperature Swivel Joints for temperatures to 500° F., working pressures to 700 psi. (c) Rotating Joints for 150-lb. steam, brine, etc. For hot and cold rolls, tumblers, platens, etc. (d) Sanitary Swivel Joints for food processing, fruit juices, dairies, etc. (e) Hydraulic Swivel Joints for pressures to 3,000 psi. For aircraft, industrial and armored equipment. (f) Flexible Lines, designed and fabricated to meet specific requirements.



WRITE FOR CATALOG NO. 50-AH

Representatives in Principal Cities



1 Typical CHIKSAN installation on hydraulic lines for aircraft landing gear.

2 Brake line installation on torque link in aircraft brake system.

CHIKSAN TRADE MARK REG.

CHIKSAN COMPANY AND SUBSIDIARY COMPANIES
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BALL-BEARING SWIVEL JOINTS FOR ALL PURPOSES

CATALOG GUIDE

86 ELECTRICAL MACHINERY

Fairbanks, Morse & Co.—Bulletin E100H, "Catechism of Electrical Machinery," presents the most important theoretical and practical features of common types of direct-current and alternating-current motors, generators, and control equipment. Intended for those who are not familiar with electrical phenomena or terminology. The text is illustrated with Fairbanks-Morse machinery, and in some cases the details of these machines are discussed.

87 METALLIC BELLOWS

Chicago Metal Hose Corp.—Catalog CMH-113 gives a complete range of sizes and metals of Flexon bellows. They are manufactured of brass, stainless steel, bronze, monel, and inconel in single and multiple-ply construction, and in various lengths, dependent upon the application requirements. They are specially suited for control devices and instrumentation; such as regulators, valves, steam traps, shaft seals, expansion connections, and flexible connectors for misalignment.

88 KEY TO REMOTE CONTROL

Automotive & Aircraft Div., American Chain & Cable Co.—Booklet "The Key to Remote Control" Tru-Lay Push-Pull Controls. Built as precise machine parts for handling push or pull loads from 30 to 1000 lb. Quality controls of long life. Operative in extreme low temperatures as well as normal temperatures. Standard parts available for making most installations with the exception of length which can be varied. Suitable for use in extreme long lengths.

89 FLEXIBLE SHAFT POWER DRIVES

Elliott Mfg. Co.—Folder No. 200, describes applications of flexible shafts for power drives and heavy-duty power drives. It gives factors which determine specifications and primary requirements in engineering flexible shaft power drives. Information required by Elliott Engineering Service in offering solutions to power transmission problems, without cost or obligation, is listed.

90 METALLURGY

Molybdenum Corp. of America—Timely information on alloying materials is given in separate pieces devoted to Molybdenum Wrought Steels, Molybdenum Cast Steels, Molybdenum Cast Irons, and to Tungsten in steel manufacture. Compositions, procedures, and data on results are given. A general catalog includes the metallurgical uses of Boron.

91 FLUID POWER EQUIPMENT

Oilgear Co.—New 8-page Bulletin 10051-A illustrates and describes complete line of fluid power pumps, motors, transmissions, cylinders, and valves. It features a new line of small constant and variable delivery pumps, a new line of axial piston motors, an improved line of standard cylinders for pressures up to 1500 psi, and a new line of heavy-duty cylinders for pressures up to 3000 psi. It introduces standard line of pilot and directional control valves, relief and foot valves, surge (pre-fill) valves, combination valves, differential valves, and auxiliary fluid equipment for pressures up to 3000 psi.

92 PIPE CEMENT LINING

Centriline Corp.—Booklet describes the method for placing a thin cement mortar lining on the inside surface of pipes in place. Typical installations and results which can be expected in pipes reconditioned after many years of use with a minimum interruption of service, are given.

93 WEIGHING AND COUNTING SCALES

Toledo Scale Co.—Brochure of 36 pages shows a wide range of applications of modern weighing, counting, and force-measuring equipment; also presents historical background on development of modern scales and balances. Published in connection with 50th Anniversary of Toledo Scale Co.

94 MATERIALS-HANDLING EQUIPMENT

Clark Equipment Co., Industrial Truck Div.—New Condensed Catalog of materials-handling machines and attachments provides basic specifications for all models of Clark fork-lift trucks, industrial towing tractors, Trucktractors and special handling attachments. Information includes capacity, dimensions, center of gravity, turning radius, lift heights, etc., for both electric and gas-powered models.

95 SURFACE ROUGHNESS MEASUREMENT

Physicists Research Co.—Catalog of profilometer equipment for measuring the roughness of practically all machined, ground, and finished surfaces directly in microinches rms. Includes description

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This pamphlet has been prepared as an educational guide, in order to give something of an introductory insight into the profession of engineering. It is dedicated to the coming generation of engineers and to the constructive contributions which they will make to the life and culture of mankind. Contents of the booklet have been divided into three main parts: The Scope of Engineering; Principal Branches of Engineering; and References to Vocational Guidance Literature.

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of profilometer operating features from the shop man's viewpoint, plus illustrations, description, and specifications for each item of standard equipment

96 NEW COPES PERFORMANCE REPORT

Continental Foundry & Machine Co., Northern Equipment Div.—New Bulletin No. 489, 16 pages, describes Copes multielement feedwater control including balanced flow at Plant Yates and Atkinson, and air-operated Flowmatic at Arkwright, all of Georgia Power Company. Included are boiler drawings, performance charts, and significant data about each plant.

97 SELF-ALIGNING COUPLINGS

Koppers Co., Inc.—Fast's Coupling Dept.—Six-page folder on Fast's self-aligning couplings gives graphic illustrations of principles and features of these couplings; table of utility factors for various kinds of connected machines; and tables of ratings for standard forged-steel couplings and heavy-duty-type couplings.

98 WATER CONDITIONING

Permutit Co.—Mixed Bed Demineralizer Booklet No. 3591 describes the operation, states advantages, and suggests when this type of unit should be used. Unit delivers "Conductivity Water," total electrolytes less than 0.5 ppm and silica below 0.1 ppm.

99 COPPER AND COPPER ALLOY SPECIFICATIONS INDEX

American Brass Co.—The first edition of this Index, published 2 years ago, and the 1949 edition, were extremely well received by thousands of men in the metal-working field. Many more thousands are doubtless unaware of its existence. It is, of course, the only compilation of its kind.

100 WOOD SLAT ROLLING DOOR

Kinnear Mfg. Co.—Bulletin No. 37-A presents ideal substitute for metal rolling doors in case defense demands make steel, aluminum, etc., unavailable. Used for years on roundhouses and in chemical atmospheres, and during last war, the door operates on same principle of efficiency as steel rolling doors. Built in any practical size for any type of commercial or industrial service opening.

101 CATHODE-RAY OSCILLOGRAPHY

Allen B. Du Mont Laboratories, Inc., Instrument Div.—"Cathode-Ray Equipment," illustrates and describes a wide choice of instruments for an even wider range of applications. Detailed descriptions and specifications. Also auxiliary instruments and accessories, as well as industrial-type cathode-ray tubes, including a detailed chart of characteristics.

102 OIL BURNERS

Ray Oil Burner Co.—New 16-page catalog gives complete listing, with illustrations, of the company's oil-burner products including: Fully automatic horizontal rotary type; steam-turbine-driven type; combination gas-oil type; semiautomatic type, and pressure-atomizing type. Booklet also features unique selector chart, plus listing of specifications and capacities.

103 VIBRATORY MATERIALS HANDLING EQUIPMENT

Syntron Co.—Catalog No. 512, 44 pages, illustrates and describes complete line of equipment, including bin vibrators, vibratory feeders, weighing and batching feeders, long conveyors, shaft seals, and power tools.

104 REDUCING VALVES, PRESSURE AND LEVEL CONTROLS, ETC.

Leslie Co.—Bulletin No. 502 describes and illustrates design, construction, and general operating features of Leslie reducing valves, pump governors, pressure controls, level controls, and temperature regulators and controllers. Interchangeability of Leslie parts is stressed. Examples of selection problems and their solutions are given. Selection charts for choosing best class and type of regulator are included.

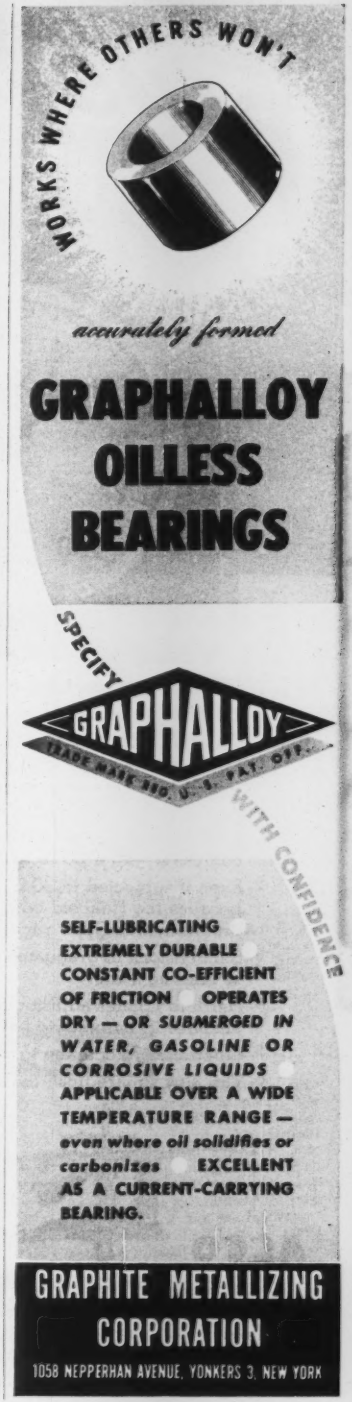
105 ROLLER CHAINS AND SPROCKETS

Diamond Chain Co., Inc.—A new 112-page engineering Catalog No. 649 containing complete information on roller chains and sprockets for industrial power transmission is offered. Engineering information relative to the application of roller chain drives is presented.

106 POWERED HAND TRUCKS

Clark Equipment Co., Industrial Truck Div.—New powered hand trucks, electric and gas-powered

Continued on Page 58



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Helicoid Gages

This Vacuum Gage is an example of the extra value at no extra cost in all Helicoid Gages.

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1. Dial in inches of mercury vacuum, reading counter-clockwise, to denote negative pressure and prevent confusion with a 30 lb. pressure gage.
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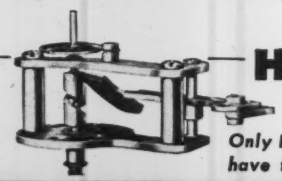

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Bridgeport 2, Connecticut

TRADE MARK

CATALOG GUIDE

with motors mounted in the drive wheel, are described in a Clark booklet. The gas-powered model employs a hydraulic drive, with engine power transmitted through a variable displacement hydraulic pump to a constant displacement hydraulic motor.

107 COMPRESSOR VALVES, PLATES, DISCS

J. H. H. Voss Co., Inc.—Literature describes Voss valves and Voss plates and discs which are applicable to any make, size, and type of air, ammonia, or gas compressors, including all the different refrigerating media; air, hydrogen, oxygen, gas, and corrosive media in vacuum-pump application. Available to manufacturers of new machinery as well as to users for replacements. Voss valves and valve plates are designed for each individual job and made on special machinery from the alloy or stainless steel best suited to the conditions under which they are to operate.

108 AXIAL-FLOW FANS

Aerovent Fan Co.—11th Edition Catalog describes Aerovent "Macheta" axial-flow exhaust and ventilation, 9 to 144-in. direct-connected, belted, extended shaft, mancooler, pulley, duct, and belted-duct fans.

109 SPREADER STOKERS

Detroit Stoker Co.—Bulletin No. 80 describes improved-type spreader stoker, having a forward moving grate that slowly and continuously discharges ash at front. Has uniform fuel distribution, high burning rates, and burns all grades of bituminous coal or lignite, wood, and refuse. Thermal efficiency is exceptionally high—either with steady or fluctuating loads.

110 SK EQUIPMENT

Schutte & Koerting Co.—New products list Folder, entitled "Index of SK Equipment and Descriptive Bulletins," lists SK products according to application and alphabetically, together with the numbered descriptive bulletin pertaining to each product.

111 HIGH-SPEED MOTION PICTURE CAMERAS

Wollensak Optical Co., Industrial & Technical Div.—Catalog contains information, specifications and applications of the 8-, 16-, and 35-mm Fastax High-Speed Motion Picture Cameras. These cameras make motion studies of mechanical electrical, physical, and anatomical reflexes and vibrations. Permit taking pictures up to 14,000 frames a sec.

112 HYDROSTATIC TUBE AND PIPE TESTING MACHINES

Hydropress, Inc.—Folder describes Hydrostatic Tube and Pipe Testing and Expanding Machines. Modern design is reflected in semiautomatic one-man operation and high production. Built in one-head, multihead, or rotary type for test pressures as high as 10,000 psi.

113 STRAIN MEASUREMENT

Hathaway Instrument Co.—4-page Catalog Leaflet entitled "Dynamic Strain Analysis—General Considerations" outlines the elements necessary for a complete dynamic strain analysis laboratory and describes briefly strain gages, five types of strain-gage amplifiers for dynamic work, and eight types of oscillographs suitable for recording 6 to 24 records simultaneously and covering a frequency response range from zero or static to 50,000 cps., Hico 3-00-1.

114 THERMOSTATS

Fenwal, Inc.—Catalog on unique Thermoswitch* Heat Control, a precision thermostat having outstanding advantages of instant response, high accuracy, wide range, rugged construction and ease of installation. Catalog describes wide application and gives full engineering details, and shows how Thermoswitch unit can often replace expensive control instruments. (*Reg. U. S. Pat. Off.)

115 NEW INSTRUMENT VALVES

Edward Valves, Inc.—New Bulletin No. 491 providing information on the new drop-forged steel Edward instrument valves for meter, gage, instrument, and other small lines. These new valves have a rating of 6000 lb WOG at 100 F or 1500 lb sp at 1000 F. Bulletin contains dimensions, weights, prices, and operating data.

116 STEEL PLATE PRODUCTION

Posey Iron Works, Inc.—Illustrated bulletin gives comprehensive description of Posey production facilities. Specific plant acreage is given and new machinery is shown. Products are also shown.

117 FLEXIBLE, SWIVEL, SWING, AND REVOLVING BALL JOINTS

Barco Mfg. Co.—For piping and lines conveying steam, oil, air, gasoline, water, chemicals, including corrosive acids and alkalis, and other fluids or gases. Types for pressures up to 750 psi, steam, and 6000 psi hydraulic. Complete range of sizes. Catalogs No. 215, "Flexible Ball Joints"; No. 265 "Rotary Swivel Joints"; No. 400 "Barco Swing Joints"; No. 300 "Revolving Joints."

118 INDUSTRIAL CLUTCHES

Hilliard Corp.—New Bulletin No. MP 4 on industrial clutches is a condensed, factual information sheet. Bulletin includes information on Hilliard over-running, single-revolution, and both light and standard series of the slip clutch. Explanatory copy and diagrams outline specifications. Especially valuable for designers. Includes list of representatives.

119 SUPER REFRACTORIES

Carborundum Co.—"Super Refractories for Boiler Furnaces," gives description of product properties, how they are put to work in various furnaces, and the benefits they provide. Many setting and application drawings, tables, and charts of special interest to boiler operators in both utility and industrial plants are included.

120 BOILER-WATER COLUMNS

Reliance Gauge Column Co.—New Bulletin No. 516 describes boiler-water columns and gage equipment such as the original "alarm" water columns, remote reading water-level gage, liquid-level alarms, illumination equipment, gage valves, gage cocks, etc.

121 METAL TURNINGS CRUSHERS

American Pulverizer Co.—Bulletin discusses value of crushed turnings in oil reclamation and scrap sale. Shows how to convert long metal turnings from a problem to a profit. Describes features, design, and construction of American crushers. Also lists approximate capacities, speeds, and power. Typical installations are shown.

122 OPTICAL COMPARATOR

National Tool Co.—Folder describes precision optical measuring instrument for fast, accurate inspection of small parts. Measurements are accomplished through a combination of a high-precision, 6-power magnifying lens and an engraved pattern or reticle.

123 DROP FORGINGS

Drop Forging Association—"Metal Quality—Hot Working Improves the Properties of Metal," a 64-page booklet recently revised and issued by the Technical Committee, Drop Forging Association, for design engineers, metallurgists, and production-management executives, explains how hot-working improves metal quality. The text describes forging-quality steel and details of the various methods of forging. Check lists of the advantages obtained by use of forgings, economic benefits, are included.

124 BLOW-THRU MULTITHERM UNITS

Clarage Fan Co.—Bulletin No. 1310. Air-conditioning units equipped with Zone Control maintaining different temperatures and different humidities in various parts of a building. Each zone individually controlled. Zone Control compensates for differences in solar radiation, exposure, wind velocity, and varying internal loads.

125 WATER TUBE BOILERS

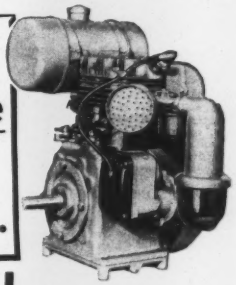
Babcock & Wilcox Co.—Bulletin No. G-70 describes the Integral Furnace Boiler, Type FJ, a completely water-cooled unit for power, process, and heating services requiring from 30,000 to 70,000 lb of steam per hr at pressures up to 800 psi. Design, construction, installation, and operation details are discussed and illustrated.

126 SPACE HEATERS

Dravo Corp.—Bulletin No. 526 describes Dravo "Counterflo" direct-fired space heaters in a range of gas- or oil-fired models with outputs from 400,000 to 2,000,000 Btu per hr. A comparison chart shows that steel requirements for these heating systems can be reduced 50 to 70 per cent through the use of direct-fired warm air heaters.

Continued on Page 58

Gain More Power Advantage for Your 3 to 6 hp. Units...



Presented here are a few of the basic facts why Wisconsin Heavy-Duty Air-Cooled Engines offer important advantages to the designing engineer, equipment manufacturer and the ultimate user:

1. Rotary type high tension magneto, with impulse coupling, mounted on outside of engine . . . operates as an entirely independent unit that can be serviced or replaced in a few minutes.

2. Self-cleaning tapered roller bearings at both ends of the crankshaft . . . will withstand side-pull or end-thrust without danger to bearings.

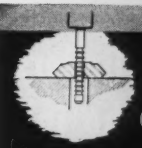
3. Maximum torque at usable speeds . . . most desirable on equipment that really has to go to work.

Our Engineering Department will be glad to co-operate with you in adapting Wisconsin Engines to your requirements. Write for detailed data.

Condensed Specifications
4-Cycle Single Cylinder Engines

	Model ABN	Model AKN
Bore	2½"	2⅞"
Stroke	2¾"	2¾"
Piston Displ. (Cu. In.)	13.5	17.8
HORSEPOWER		
1800 R.P.M.	2.5	3.6
2200 R.P.M.	3.1	4.5
2600 R.P.M.	3.7	5.3
3000 R.P.M.	4.2	5.9
3600 R.P.M.	4.6	6.2
No. of Piston Rings	4	
Fuel Tank Cap.	1 Gal.	
Weight, lbs.	Net 76	Crated 89
Standard Engine		

WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines
MILWAUKEE 46, WISCONSIN



HELPFUL HINTS ON INCREASING BROACH LIFE

QUICK FACTS! *Page C-4*

OILS FOR BROACHING

Heavy Demand on Cutting Fluid

Broaching places a great demand on the cutting fluid due to the large amount of metal being removed and the necessity for maximum broach life and finish.

Stuart's THREDKUT and related products, due to their high effective sulphur content, have been outstanding for the most severe broaching work. Active or effective sulphur in an oil serves as an anti-weld agent preventing metal seizure, welding and scuffing.

Slow Speed Broaching

For unusually slow speed broaching of ferrous materials it is often desirable to use oils of heavier viscosity (such as THREDKUT #25) that will not drain off of the broach and the work before it has completed its mission.

Good Rule of Thumb

When excessive front clearance wear is observed on the cutting teeth of the broach, DECREASE active sulphur in the oil by diluting with paraffin oil or other blending oils. When poor finish occurs due to pick-up and welding, apply Stuart's THREDKUT or THREDKUT #99 straight.

Use of Water-Mix Cutting Fluids

On some flat surface broaching and on round hole work it is often desirable to use a water-mix cutting fluid of top quality. Stuart's SOLVOL, a heavy duty "soluble" oil, is widely recommended.

PROOF!

"With their regular oil they only broached 12 pieces when the broach wore badly and bugged. This is a 4140, 240-270 Brinell forged gear blank with a 1" hole and ¼" deep keyway to broach at one pass with a combination broach, 1' for the round hole first, followed by 2' for the keyway. "They put in THREDKUT #99 and the broach was still in good condition after running 1500 pieces." WRITE FOR LITERATURE and ask to have a D. A. Stuart representative call.

D. A. Stuart Oil Co.
2741 S. Troy Street, Chicago 23, Illinois

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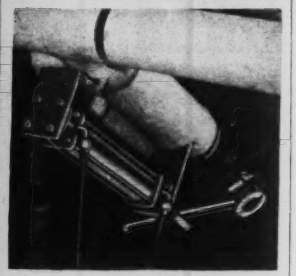

CYLINDER CONTROLS PLUG VALVE FOR AUTOMATIC BATCHING

Continuous, accurate batching of asphalt mixture from a weighing machine, by automatic remote control, is the result of this application of Ledeen cylinders.

A 2" diam. x 12" stroke Ledeen Heavy Duty air cylinder, using 100 P. S. I. line pressure, operates a 1½" diam. steam jacketed plug valve. Valve controls flow of asphalt-mix from weighing machine to mixer. Manual operation is completely eliminated. Batching and mixing is improved.

Standard Ledeen cylinders and mounting attachments are available from distributors' stock in major cities. Special cylinders on order.

Write for New Bulletin 500.

There are Ledeen *Medium Duty, Heavy Duty* and *Super Duty* cylinders for air, oil or water operation ready to help you, wherever you have to push or pull: • lift or lower • press or squeeze • tilt or turn • open or close

Ledeen Cylinders are Good Cylinders • Ledeen Cylinders are Good Cylinders • Ledeen Cylinders are Good Cylinders • Ledeen Cylinders are Good Cylinders •

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1600 San Pedro
Los Angeles 15, Calif.

127 SPREADER STOKERS

Detroit Stoker Co.—Bulletin No. 890 describes a spreader stoker having overthrow rotors that provide exceptionally uniform fuel distribution. Available with stationary, hand-dumping, and power-dumping grates. Many sizes assure efficient application to all types of boilers and steam generators. Burns all grades of bituminous coal, lignite, and various kinds of wood, and other refuse.

128 BREECH LOCK VALVES

Lunkenheimer Co.—New Circular No. 552–12–48 describes Lunkenheimer's exclusively designed and patented breech-lock seal-welded-bonnet cast-steel valves.

129 MICARTA

Westinghouse Electric Corp.—Booklet No. B-3184-D, "The Industrial Plastic Data Book," explains fully how micarta is used—and why. Grade selection tables, sizes and shapes, mechanical and electrical tube properties, physical proterties, and other performance and working information are given.

130 WORM GEAR SPEED REDUCERS

D. O. James Gear Mfg. Co.—Current 8-page illustrated Catalog No. 45-C containing valuable informative engineering data and prices on single and double worm gear reducers. Type "S" or Single Reduction comes in 24 sizes, in ratio ranges of 5.66:1 to 100:1 and from .04 to 15 horse-power. Double worm gear reducers are available in 10 sizes with ratio ranges of 87:1 to 10,000:1 and from 106 in-lb to 3480 in-lb output torque. Stock sizes, available for immediate shipment, are plainly indicated.

131 WATER TUBE BOILERS

Springfield Boiler Co.—Illustrated technical Bulletin describes 2-drum bent-tube steam generators, sectional header straight-tube boilers, and standardized Type M boilers produced by this company. Bulletin also presents reports on boiler installations, power cost reducing programs, and describes Springfield design and construction features.

132 STEEL PLATE CONSTRUCTION

Tippett & Wood—Literature covers design and fabrication of steel plate work required for power plants. Included are steel stacks, breechings, ducts, coal bins, ash bins, boiler casings, storage tanks, pontoons, water towers, standpipes, etc.

133 GRAPHITE PRODUCTS

Joseph Dixon Crucible Co.—A 23-page booklet contains data on the history, sources of supply, characteristics of various graphites, specific properties, recommendations for the selection of the best-suited graphite for a particular requirement, and general information about products made from or with natural graphite.

134 ASH SLUICING SYSTEMS

United Conveyor Corp.—Bulletin No. 2S 50 on Ash Sluicing Systems, features the latest developments on hydraulic transportation of ashes, fly ashes, and soot with Jetpulsion pump, which eliminates entirely the use of mechanical ash pumps.

135 PREFABRICATED PIPING

Western Piping Supply Div., The Lummus Co.—Bulletin WP-1 pictures and describes the complete engineering and fabricating facilities available for producing all types of pressure piping subassemblies, in carbon steel and all alloys, to meet every requirement of industry. Covered are all of the Division's products: pipe bends, coils, headers, manifolds, Vanstone piping, power piping, process piping, and welded assemblies.

136 KEYWAY BROACH KIT

du Mont Corp.—New Bulletin on "Minute Man" Keyway Broach Kits manufactured by The du Mont Corporation, gives complete range of sizes and prices and describes operation of kit to cut keyways by hand in one minute in gears, milling cutters, pulley hubs, couplings, etc. Kits are available in sizes to cut keyways from $^1/_{16}$ to 1 in. wide in bore diameters from $^1/_2$ to 3 in. by $^1/_{16}$-in. steps.

137 PRECIPITATING SOFTENER AND COAGULATOR

Worthington Pump & Machinery Corp.—New Bulletin W-212-B6 describes Type CM precipitating softener and coagulator, in which energy for floc preparation is mechanical. Bulletin describes the flow circuit, diagrams the flow, and answers nine questions in system appraisal. Chemical feeders, dual-purpose pump and chemical proportioning system are pictured and described.

138 PIPE LINE STRAINERS

J. A. Zurn Mfg. Co.—Pipe Line Data Strainer Manual No. 950, contains an engineering study of Duplex, Sinlex, and "Y" type pipeline strainers.

139 CAST-IRON PULLEYS

W. A. Jones Foundry & Machine Co.—Catalog No. 83, shows standard as well as special pulleys, contains engineering data to help you with your design problems and complete price information on all types of standard pulleys.

140 SPRAYING NOZZLES

Spraying Systems Co.—30-page Catalog No. 22 lists hundreds of nozzles in tabular form to exactly meet requirements for aerating, air conditioning, chemical and metal processing, water cooling, aggregate washing, spray drying, descaling, cooling towers, condensers, spray ponds, etc. Gives spray characteristics, construction, materials, liquids sprayed, impact, use recommendations, sizes, pressures, capacities, and dimensions.

141 SPREADER STOKERS

Westinghouse Electric Corp.—Booklet No. B-4553 describes ideal firing equipment for capacities ranging from 50,000 lb of steam per hr to upwards of 350,000 lb per hr. Outstanding features of spreader-type firing are explained. Accurate control of fuel feed and distribution is made possible by use of unit hydraulic drive plus correct balance of primary and secondary air supply. Designed and built for severe continuous service.

142 RUBBER AND PLASTICS CALENDERS

Farrel-Birmingham Co., Inc.—New Bulletin No. 174, describes latest improvements in calender design and gives general construction specifications. Diagrams show roll arrangements for various applications. Photographs illustrate numerous types of calenders. Also included are parts lists and drawings for three-roll and four-roll calenders; and details of the latest Z-type calenders.

143 MOTOR BASE

Lovejoy Flexible Coupling Co.—Illustrated catalog sheet on new tilting motor base for fractional hp motors, gives full description and specifications for low-priced adjustable motor base. Besides its use with variable-speed pulleys, it also acts as a belt tightener.

144 CHAINS AND SPROCKETS

Jeffrey Mfg. Co.—New Catalog No. A418 covers chains and sprockets for both new and replacement service on elevating and conveying equipment, and for drives. Twenty-two types of malleable, steel, and alloy chains as well as many types designed for special requirements—with particular emphasis to drive chains.

145 CUTTING FLUIDS

D. A. Stuart Oil Co.—A reliable guide to better machining through proper selection and application of cutting fluids is offered. Contains handy chart which aids in selecting cutting fluids for various metal-working operations. Two articles—"Mechanisms of Metal Cutting" and "Chemistry of Cutting Fluids" will help the shop man to better understand cutting-fluid functions and enable him to obtain more efficient operation.

146 METAL BENDING

O'Neil-Irwin Mfg. Co.—New 32-page bending manual contains information on a wide variety of forming operations. The bending of tubing, angle, channel, extrusions as well as solid materials is graphically illustrated. Detailed prints show the exact manner in which any rotary-type bending machine can be tooled for precision bending. The manual outlines the recommended steps in designing parts to be formed, choice of materials, and selection of bending equipment.

147 AIR FILTER GAGES

Ellison Draft Gage Co.—Bulletin No. 114 describes function and application of inclined gages and Bell-type dial gages for indicating air-flow resistance through air filters on ducts. Sketches show how to mount gages on ducts. Inclined gages have large brass oil chamber; extreme accuracy.

148 SPEED REDUCERS

Westinghouse Electric Corp.—Bulletin SM 5336 shows graphically what to look for in speed reducers. Included are horizontal parallel shaft units, vertical shaft units, and special units. All feature a strong tight case, taper roller bearings, provisions for ample lubrication, screw action of single helical gears, and many other design characteristics that provide long trouble-free performance.

BUYER'S CATALOG GUIDE

149 COPPER AND COPPER ALLOYS

Revere Copper and Brass, Inc.—Booklet contains complete technical data on all leading Revere alloys. It includes material on coppers, brasses, bronze alloys, nickel alloys, manufactured forms, aluminum products, welded steel tube, lockseam tube, welding techniques, and a condensed list of products.

150 HOT-WATER HEATERS

Patterson-Kelley Co., Inc.—Catalog No. 202 describes 2-, 4-, and 6-pass shell and U-tube water heaters and condensate coolers with data on how to select the type and size for a given installation. Capacity tables for varying water temperatures and steam pressures are included.

151 TURBO PUMPS

J. S. Coffin, Jr., Co.—New Bulletin "S" illustrates compact centrifugal pumps with integral steam turbines; lists services, maximum ratings, and data for proposal; shows how destructive casing erosion-corrosion and interstage leakage are avoided; describes governing gear which reduces and restores speed with loss and recovery of suction, with wide range sensitive constant pressure control.

152 POWER PLANT EQUIPMENT

Jeffrey Mfg. Co.—Catalog No. 778-A contains 50 pages of useful information on coal and ash-handling machinery for power plants and boiler houses. The bulletin covers silo storage systems, bucket elevators, conveyors of all kinds, skip hoists, weigh larries, track hoppers, feeders, crushers, etc.

153 PRESSURE REGULATORS

Chaplin-Fulton Manufacturing Co.—Bulletin 46 describes Model 46 pressure regulator. Two new features are used in this design: The O-Ring to replace the stuffing box, and the "Dynaknob" to improve the degree of accuracy in outlet pressure control.

154 FRACTIONAL HORSEPOWER GEARS

Gear Specialties, Inc.—6-page Bulletin illustrates and describes complete facilities together with different types and applications of G.S. small gears from 12 to 96 diametrial pitch. Handy Diametrial Pitch and Circular Pitch charts included.

155 BEARING SELECTION

W. A. Jones Foundry & Machine Co.—Catalog No. 88, a 24-page bulletin on "Timken Equipped Pillow Blocks" and a new line of "Timken Equipped Protected Screw Take-ups," contains many illustrations and good engineering information on the rating and selecting of bearings.

156 INSTRUMENTS—RECORDERS

Brush Development Co.—Brush Recording Analyzers provide immediately usable, permanent records of data on special problems: electrical, mechanical, acoustical. New Bulletin describes Recording Analyzers applicable to studies of d-c or a-c voltages or currents, strains, displacements, light intensities, temperatures, other static or dynamic conditions; oscillographs, amplifiers, instrument accessories, acoustical instruments.

157 ELEVATOR PLANTS

Charles W. Lerch & Assoc.—"Cost of Errors In Elevator Plants" is a new booklet for all building owners, managers, and administrators—especially those who operate office buildings, hospitals, lofts, apartments, and hotels.

158 STEAM AND LIQUID CONTROL EQUIPMENT

O. C. Keckley Co.—Catalog No. 51, contains 56 pages of illustrations and engineering data on precision pressure regulators, temperature regulators, float valves, water gages, float boxes, safety and relief valves, strainers, etc. Drawings, layout diagrams, dimensions, and capacity tables are included.

159 FORGED STEEL VALVES

Ohio Injector Co.—New Bulletin describes fully the complete line of forged-steel gate, globe, angle, and check valves, 600-lb pressure type; and screwed, flanged, solid weld connections. Also, Bulletin No. 805 describes a new and complete line of iron gate valves.

160 INDUCTION MOTORS

Westinghouse Electric Corp.—Booklet B-4731, LifeLine, the space-saving, steel construction, streamline design has been extended to 700 hp. Having operated successfully for years in the 1 to 20-hp range, the same features, greater electrical strength, less bearing maintenance, and smoother operation, are available for big hp duty.

161 WASTE TREATMENT

Jeffrey Mfg. Co.—A complete line of equipment for treating sewage, water, and industrial waste is covered in Catalog No. 833. Pictures and describes Jeffrey sludge collectors and elevators, grit washers and collectors, flocculation equipment, grinders, chemical feeders, bar screens, etc. Many drawings to help the engineer.

Continued on Page 60

Read the various items listed . . . one catalog may hold the solution to your present problem . . . select those items of interest to you. *Distribution by us to students is not included.* The coupon on page 44 should be mailed on or before May 15 in U. S., May 25 elsewhere.

You can have "3 Keys!"

Our book "3 Keys to Satisfaction" is 72 pages of facts and figures of significance to designing engineers. It sets out the vital relationship between good design, good steel and good treatment, and shows how to get a specified service from a part at least cost.

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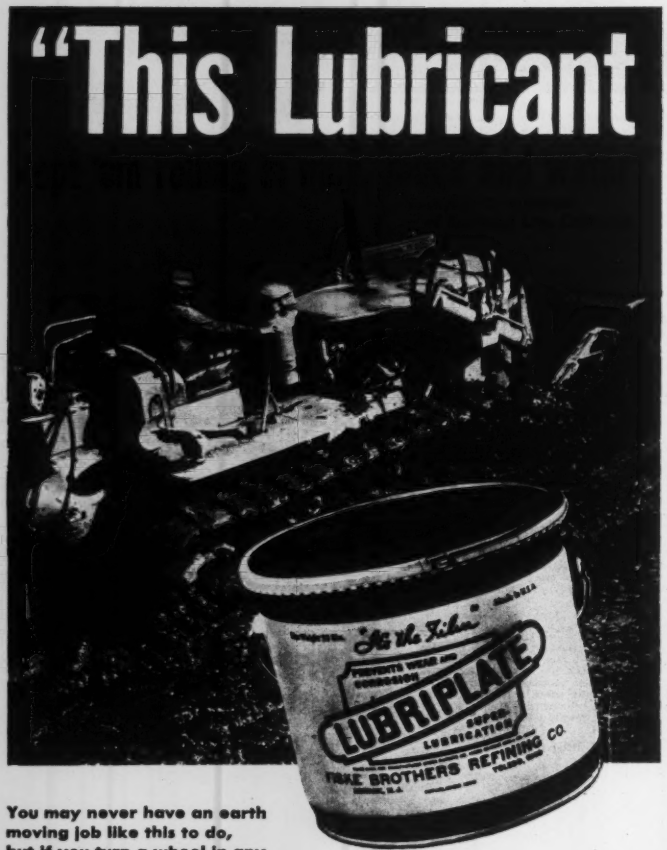

You may never have an earth moving job like this to do, but if you turn a wheel in any industry you can profit from Mr. Archibald's experience.

"The Leslie Salt Company called for bids for the conversion of 500 acres of salt marsh into crystallizing ponds for the production of bulk salt. The going was so tough that none of the several contractors invited to bid would take the job on a fixed price contract. Due to our success on similar work, the job was given to us on a cost plus basis.

"We moved in eighteen tractors as power units and the necessary Carryalls, Sheep Foots, Jeeps and other equipment. As soon as we removed the upper crust there was nothing but peat and marsh to run on. Tractors would sink in over the track rolls. To keep equipment rolling would require a special lubricant.

"Knowing from past experience that LUBRIPLATE No. 107 not only reduced friction to a minimum, but it also prevented rust even in salt water and would seal out the muck, we adopted it for track and general lubrication. We selected LUBRIPLATE APG-140 for all transmissions and final drives. The effectiveness of these two LUBRIPLATE Products is evidenced by the fact that during the entire job there were no replacements of track rollers nor were there any tie-ups of equipment due to replacement or breakage."

J. O. Archibald

Yes, LUBRIPLATE Lubricants are different!

They reduce friction, wear and power consumption, prevent rust and corrosion and last longer than ordinary lubricants. LUBRIPLATE Lubricants are available from the lightest fluids to the heaviest density greases. There is a LUBRIPLATE Product best for your every lubrication need. Write for information about the use of them in your industry.

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DEALERS EVERYWHERE—SEE YOUR CLASSIFIED TELEPHONE BOOK

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CATALOG GUIDE

162 ELECTRONIC MOISTURE TESTER

Seedburo Equipment Co.—Latest literature on the new Steinlite electronic moisture tester explains variety of products which can be moisture-tested. Accurate tests made in 1 min without destroying sample. Specifications show it registers moisture content from 1½ to 50 per cent. Consistent readings assured. 16,000 in use.

163 FEEDWATER CONTROL

Bailey Meter Co.—Bulletin No. 105-C describes latest developments in the Bailey Three-Element Feed Water Control. Bulletin discusses problems encountered in feedwater control and tells how the Bailey control system helps solve them. Diagrams, cutaway views, typical chart records, and installation photographs are included.

164 ALUMINUM TUBING

Aluminum Co. of America—8-page booklet on Instrument Lines of Alcoa Aluminum, is illustrated and crammed with facts on bursting pressures, mechanical properties, conversion factors, price, and applications.

165 SPEED RECORDERS—TACHOMETERS

Leeds & Northrup Co.—Catalog No. N-27, 20 pages, describes application of Speedomax to speed recording, as well as new and improved tachometers for use with both Micromax and Speedomax. The Catalog discusses and compares the principles of operation of Micromax and Speedomax instruments. A tachometer which operates in any position at speeds up to 2500 rpm, as well as other standard and explosion-resistant models with operating speeds ranging as high as 30,000 rpm, are included.

166 HYDRAULIC PUMPS

American Engineering Co.—Folder describes the AE Hydramite, a radically new radial multipiston, constant displacement, oil-operated pressure generator that maintains pressures up to 5000 psi. Among features mentioned are choice of 3, 5, or 10-gpm capacities; foot, flange, or face mounting; direct-drive through a flexible coupling; over-all efficiency of 85 per cent.

167 LUBRICATED PLUG VALVES

Homestead Valve Mfg. Co.—Valve Reference Book 39, Section 5, gives complete data on a new self-sealed lubricated plug valve which automatically compensates for wear and works longer without relubricating. Lubricated by any of three methods it offers full port area, full port seal.

168 ADJUSTABLE FLOW REGULATORS

Waterman Engineering Co.—An adjustable flow regulator for cylinder speed control is described. This adjustable regulator gives a constant rate of flow regardless of pressure fluctuations or change in work resistance at any setting within the adjustable range. Adjustable range is 50 per cent of the calibrated flow rate in gpm. It is available for hydraulic systems with operating pressures to 3000 psi. Line sizes are ¼, ⅜, ½, and ¾ in. NPT (dry seal). Maximum controlled flow is 16 gpm.

169 ROLLER CHAINS

Whitney Chain Co.—New 72-page Catalog RCE-50R shows how roller-chain drives can be applied to a wide range of production equipment to step up output and reduce costs. Comprehensive contents include application photographs, chain illustrations, dimensions, and tables. Complete engineering data is arranged to simplify selection of the proper chain drive for any application.

170 STEAM GENERATORS

Titusville Iron Works Co.—Boilers built to use every type of fuel economically are described in Bulletin B-3250A. Includes dimensional diagrams, operational data, cutaway drawings.

171 MULTISTAGE CENTRIFUGAL PUMPS

Ingersoll-Rand Co.—Form 7233 describes a new line of pumps for applications to 1400 psi and 1600 gpm. Known as the HMTA, these units are one of the most outstanding developments in the centrifugal-pump field. Literature available on other pumps from 5 to 90,000 gpm and pressures to 3000 psi.

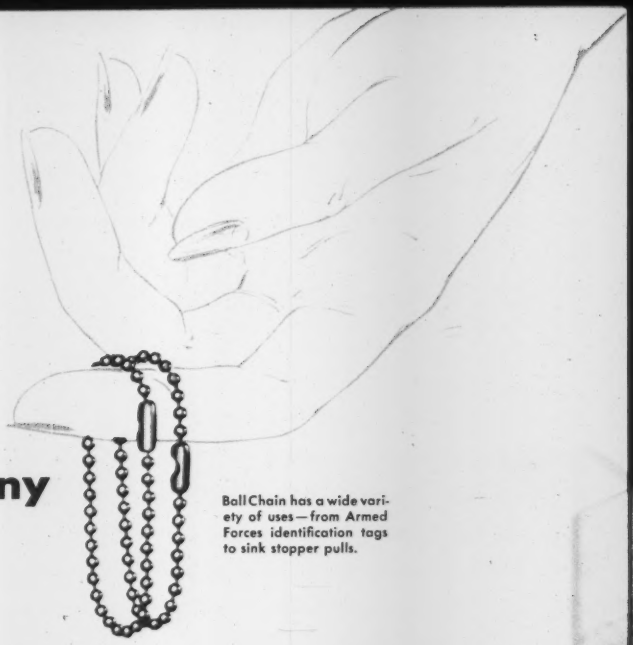
172 DRAWING PENCIL

Eagle Pencil Co.—Sample of new improved Turquoise drawing pencil made with 100 per cent electronic graphite is offered. Laboratory tests show it to be smoother, longer-wearing, blacker, more opaque, and capable of holding a fine needle point without crumbling. Specify degree desired.

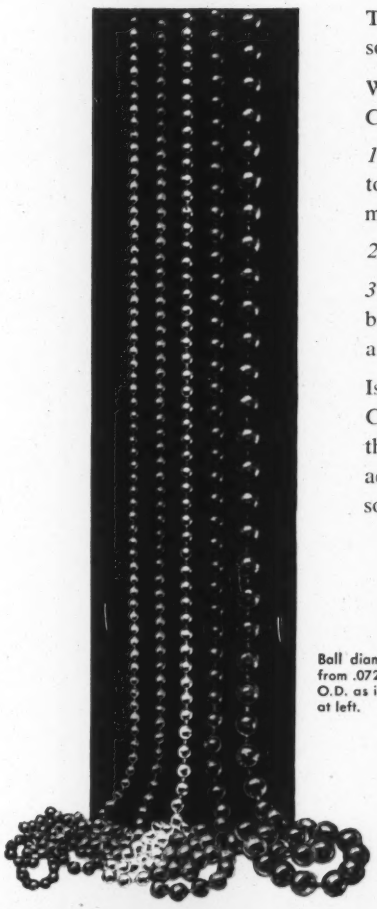
Continued on Page 63

FOR SALE

. . . two for a penny



Ball Chain has a wide variety of uses—from Armed Forces identification tags to sink stopper pulls.



Ball diameters vary from .072" to .187" O.D. as illustrated at left.

That, roughly, is the manufacturer's price in quantity for these solid brass key chains.

What makes it possible? These three factors, as outlined by the Ball Chain Manufacturing Co., Inc., of Mount Vernon, New York:

1. Ingenuity in the design of multiple dies of extremely close tolerances . . . and their adaptation to specially developed automatic equipment.

2. High production over long periods.

3. Uncompromising standards of quality in every mill shipment of brass, copper or nickel silver strip necessary for the fabrication of a wide variety of Ball Chains and attachments.

Isn't it significant that "Ball Chain" considers The American Brass Company its most dependable source of supply for metals made to the most exacting requirements; composition, anneal, flatness across the entire strip width, and uniform gage of metal which, in some instances, must be within .00025".

51101

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COPPER • BRASS • BRONZE

WHEREVER METAL TAKES A BEATING

. . . in manufacturing, in service, or both—
no other alloys possess the combination of
properties of Phosphor Bronze. And *nowhere* is
finer Phosphor Bronze produced than in
the mills of The American Brass Company—
in sheet, wire, rod and tube.

Illustrated here are a few of the myriad of bellows and bellows devices made of Anaconda Phosphor Bronze and other Copper Alloys by The Bridgeport Thermostat Division of Robertshaw Fulton Controls Co., Bridgeport, Conn.

ANACONDA PHOSPHOR BRONZE

HIGH

Tensile strength
Elastic limit
Resistance to fatigue
Resistance to corrosion
Resistance to wear

CATALOG GUIDE

173 MECHANICAL SPRINGS—THEIR ENGINEERING AND DESIGN

Associated Spring Corp.—64-page Handbook of design information and engineering charts and formulas, covering all types of springs, snap rings, and spring washers. Includes tables of physical properties of spring materials, weights of flat steel and round wire, steel hardness numbers, etc. Special sections on motor springs, hairsprings, hot-wound springs, and Belleville springs.

174 EXCEN CRUSHER FOR CLINKERS

United Conveyor Corp.—Publication describes Excen Crushers for clinkers for use with either pneumatic or hydraulic ash-conveyor systems. This crusher is of relatively small size with low head clearance for installation below the door of the ash pit hopper for feeding directly into the ash conveyor.

175 FLEXIBLE SHAFTING

F. W. Stewart Mfg. Corp.—Bulletin "Flexible Shaft Assemblies," describes new Power Drive Circle Ess Flexible Shafting. Greater opportunity for diversified streamlined power transmission is offered for use in all types of metal, plastics, porcelain or woodwork. They can be applied in hundreds of finished operations. Three types of Power Drive Flexible Shafts are presented—for heavy, medium, and light duty in commercial or industrial work.

176 UNIT HEATERS, FANS, BLOWERS, TURBINES

L. J. Wing Mfg. Co.—Individual Bulletins may be had as follows: HR-5, Revolving Unit Heaters; GH-1, Gas-Fired Unit Heaters; U-7, Utility Unit Heaters; HS-3, Heater Sections; F-11, Ventilating and Duct Fans; TC-1, Transformer Cooling Fans; SH-1, Shutters and Penthouses; SW-50, Forced Draft Blowers and Turbines; I-49 Draft Inducers; SV-3A, Ship Ventilators.

177 DIE-LESS DUPLICATING

O'Neil-Irwin Mfg. Co.—Hydraulic Power Bender, Variable Speed Powershear, and Air Powered Rod Parter have all been added to the "Di-Acro" Line to increase the production possibilities of the "Di-Acro" System of Die-Less Duplicating. 40-page "Di-Acro" Catalog contains complete information covering these power machines as well as all manually operated "Di-Acro" benders, brakes, shears, rod parters, notchers, and punches, which are offered in a variety of sizes.

178 SPEED REDUCERS

Cone-Drive Gears, Div. of Michigan Tool Co.—Condensed Catalog, Bulletin 8001-40, of standard double-enveloping gear speed reducers, covering some 190,000 combinations of sizes, ratios, and types (all available from stock) into a single 8-page bulletin. The bulletin contains complete information on ratings of all sizes and types, dimensional drawings and specifications, features, how-to-order information, etc.

179 FLEXIBLE COUPLINGS

Lovejoy Flexible Coupling Co.—Illustrated Catalog with Selector Charts. Grouping and application of L-R Flexible Couplings. Describes and pictures various types of couplings, with cutaway views and diagrams. New couplings for d-c standard mill motors. Selector Charts make it easy to choose correct type and size of coupling with proper cushion material for application.

180 BOILER FEEDWATER CONTROL

Republic Flow Meters Co.—New Bulletin No. S-52, describing and fully illustrating the one, two, and three-element boiler feedwater control system. A comparison of the three systems and the advantages of each are featured in this 8-page brochure.

181 STEAM TURBINES

Terry Steam Turbine Co.—Bulletins in loose-leaf form which cover a complete description of Terry solid wheel turbines with cross-section drawings of typical units for both moderate and high steam pressure conditions; a description of the Terry axial-flow impulse, both single-stage and multistage. Terry gears are used for speed increasing and speed reducing.

182 PORTABLE FOLDING CONVEYOR

Seedburo Equipment Co.—Illustrated literature on the Hytrol portable folding conveyor shows how it handles bags, boxes, bundles, bales, and cartons. Folds to half its length; light; mobile; one man operates. Specifications include five sizes—10 to 20 ft.; reversible. Delivery angle changeable while operating. Stores in area 1/2-yd square.

Continued on Page 64

A modern Bruning BW machine will print up to 105 square feet per minute

The Bruning Model 93 BW machine makes prints up to 46 inches wide at speeds up to 30 feet a minute. Prints are fully developed, regardless of speed. They come out flat, dry, odorless, and ready for immediate use.

With such speed, it is possible to break bottlenecks in black-and-white prints, and still have capacity for other types of work.

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- Twenty different color combinations are available, and copies can be made on an unrivalled selection of card stocks, acetates, films and cloths as well as on papers of different weights and speeds.

Bruning BW machines do *not* use a vapor developer, hence emit no fumes, need no exhaust vents, no plumbing connections. They do not require a specially trained operator; *anyone* can easily operate a BW machine.

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BOILER FEED PUMPS
Now being built for

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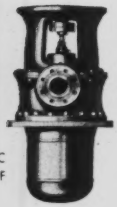
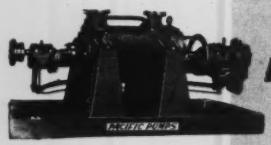
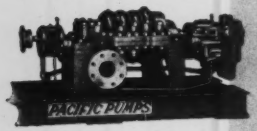


PACIFIC TYPE WBF



PACIFIC TYPE ABF

PACIFIC TYPE IBF



PACIFIC TYPE JBF

TYPE	QUANTITY	Pounds Per Hour	Degrees Temp.	Pounds Pressure
WBF	11 Pumps	47,700	259F	710
ABF	3 Pumps	230,000	281F	1110
	3 Pumps	358,120	220F	1300
	4 Pumps	350,000	300	1060
IBF	3 Pumps	425,000	310F	1825
	3 Pumps	495,000	306F	1619
	2 Pumps	450,000	310	1600
	6 Pumps	405,000	305	1750
	3 Pumps	450,000	310	1825
JBF	2 Pumps	163,600	260F	490
	1 Pump	117,500	250F	775
	3 Pumps	300,000	240	1000

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CATALOG GUIDE

183 PIPING AND FITTINGS

Midwest Piping & Supply Co.—"Midwest" Piping Products—Catalog 48, 184 pages of technical information and prices on welding fittings, forged-steel flanges, and prefabricated piping. A convenient handbook for the pressure and process piping industry; contains digests of pipe and fitting specifications, suggestions for piping design and welding, layout data, formulas, etc.

184 BALL AND ROLLER BEARINGS

Aetna Ball & Roller Bearing Co.—Latest 52-page Catalog gives specifications on Aetna's full line of standard ball thrust bearings, clutch release bearings, ball retainers, and hardened and ground washers. Contains technical data for design engineers, useful calculations and formulas, important application principles, fundamentals of proper lubrication, bearing selection and care. Shows the wide variety of special bearings and precision parts falling within the scope of Aetna facilities. Full line includes standard and special ball thrust bearings.

185 AIR-COOLED ENGINES

Briggs & Stratton Corp.—Folder printed in two colors showing complete line of current single-cylinder, 4-cycle, air-cooled engines. Includes dimensional specifications and horsepower data.

186 HIGH VACUUM APPARATUS

Central Scientific Co.—Booklet, 48 pages, on high vacuum apparatus includes suggestions for planning a high-vacuum system; information on pumping speed; explanation of merit factor, connections and speed of evacuation, low-pressure technique, and other data, together with a complete listing of Cenco mechanical pumps, D-P diffusion pumps and Cenco gages, oils, traps, and other vacuum accessories, including the New Hypervac 100 Pump with ultimate vacuum of better than 0.1 (often 0.02) micron of mercury.

187 GEAR TURBINES

Westinghouse Electric Corp.—Booklet No. B-4346. The efficiency of high-speed single-stage steam-turbines is brought to slower-speed driven equipment such as pumps, fans, compressors, and generators with low operating cost and minimum maintenance. The type-E turbine close-coupled to a rugged, compact, speed-reduction unit is the answer. Fully illustrated and diagramed.

188 THERMOSTATIC BIMETAL

W. M. Chace Co.—64-page Reference Manual to aid engineers in design of actuating elements for temperature-responsive devices. Contains applications of Chace Thermostatic Bimetal, elements of thermostat design, proper heat-treatment for bimetal, various formulas and calculations, descriptions of 30 bimetals with 30 full-page charts and data describing physical properties of each bimetal.

189 ELECTRIC MOTORS

Howell Electric Motors Co.—"Red Band" Motors customers' price Catalog available and also descriptive bulletins separately describing motor types including general-purpose squirrel-cage induction motors totally enclosed, elevator motors, explosion-proof, multispeed and sanitary motors, and also a bulletin on fractional horsepower ratings. Also condensed price sheets and bulletins AC-2 are available, the latter listing recommendations for various types of motors used on typical applications. The company specializes in industrial a-c motors from 1/16 to 200 hp.

190 POWER PRODUCTS DIRECTORY

Allis-Chalmers Mfg. Co.—This 32-page Directory, 25B6057, lists the more than 1600 Allis-Chalmers products made for power generation, power distribution, and power utilization together with engineering literature available on a wide range of equipment for the farm, mine, industry, and utility.

191 PNEUMATIC ATOMIZING NOZZLES

Spraying Systems Co.—11-page illustrated Catalog No. 23 lists wide range of types, sizes, and materials as standard equipment to meet exact needs in capacities, spray types, and characteristics for atomizing any liquid that flows; for industrial and chemical processing and scientific research. Gives complete engineering information.

192 SPEED REDUCERS

W. A. Jones Foundry & Machine Co.—Bulletin No. 68 covers the latest information on Jones Worm Gear Speed Reducers. Heavy-duty machines are furnished in type "H" with worm below gear and in type "R" with worm above gear. They have horsepower ratings in accordance with the recommended practice of the American Gear Manufacturers Association.

CATALOG GUIDE

193 FLEXIBLE COUPLINGS, UNIVERSAL JOINTS AND VARIABLE SPEED PULLEYS

Lovejoy Flexible Coupling Co.—Complete Catalog of—"Lovejoy Flexible Couplings," many hundreds of thousands of them giving satisfactory service on everything from oil burners to excavators—"Lovejoy-Dix Universal Joints," precision built from finest alloy steels combined with extremely careful design, will operate at a much greater angle than the normal joint—"Lovejoy-Ideal Variable Speed Pulleys, Bases, Sheaves, Belts and Transmissions." Fully described and illustrated. Contains engineering data and charts.

194 STEAM GENERATORS AND FURNACES

Petro-Chem Development Co.—Two Technical Bulletins: 50-1 and 50-2, which describe and illustrate Iso-Flow Steam Generators and Iso-Flow Furnaces. Bulletin 50-2 contains a detailed summary of the design and operating characteristics and operating test data on a 30,000 lb per hr Iso-Flow steam generator installation. Bulletin 50-1 describes and illustrates the Petro-Chem Iso-Flow furnace, radiant convection design, and includes the significant design and operating characteristics of these cylindrical furnaces which are in extensive use throughout the petroleum, chemical, and allied industries.

195 BLOWERS, EXHAUSTERS, PUMPS, ETC.

Roots-Connersville Blower Corp.—Regularly issued individual Bulletins covering Centrifugal Blowers and Exhausters, Rotary Positive Blowers, Gas Pumps, Liquid and Vacuum Pumps; Positive Displacement Meters, and Inert Gas Generators.

196 WORM GEAR SPEED REDUCERS

D. O. James Gear Mfg. Co.—Catalog 45-B covers Worm Gear Speed Reduction. Contains 56 pages of valuable information on Type "H" worm, helical worm, and double worm gear speed reducers. Product and installation illustrations, selection practices and load characters, rating tables and specifications, price list section, and weight tables are included.

Continued on Page 66

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500,000 Mail boxes in the United States are your partners in the fight against cancer.

A contribution addressed to "Cancer" in care of your local post office will help guard your family, yourself and your community.

Next time you see a mail box, "put 'er there, partner!" . . . as generously as you can.

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Here is my contribution of $ .....
in support of the Cancer Crusade.

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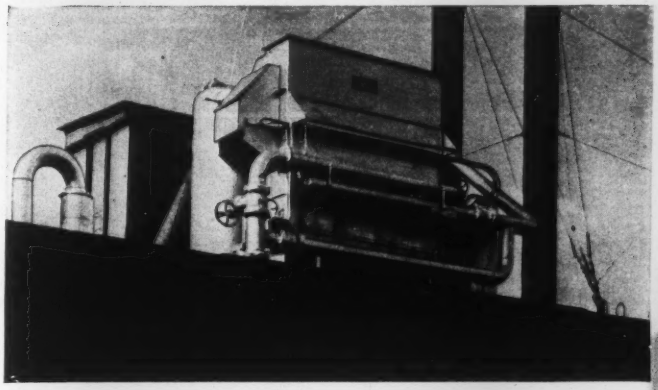
Direct saving of cooling water expense returns to you the cost of a Niagara Aero After Cooler in less than two years.



How to Get Drier Compressed Air:

It prevents many troubles and saves much expense

● NIAGARA AERO AFTER COOLER cools compressed air or gas below the temperature of the surrounding atmosphere. Therefore you get no further condensation in your lines. You save much in repairs to pneumatic tools and equipment; you save much interruption to production; you save water damage in paint spraying, in air cleaning, in any process where compressed air comes in contact with your materials or parts in manufacturing (sand blasting, for example).

Niagara Aero After Cooler uses evaporative cooling, saving 95% of your cooling water consumption. This saving quickly returns the cost of the equipment to the owner or makes extra cooling water available for other processes.

The Niagara Aero After Cooler produces compressed air with 30% to 50% less moisture than by ordinary cooling methods. Other Niagara equipment provides bone-dry air for processes requiring it.

If you have an air problem or a cooling problem, a Niagara engineer probably has an answer that will improve your process or save you operating or maintenance expense.

Write for Bulletin 98

NIAGARA BLOWER COMPANY

Over 35 Years Service in Industrial Air Engineering

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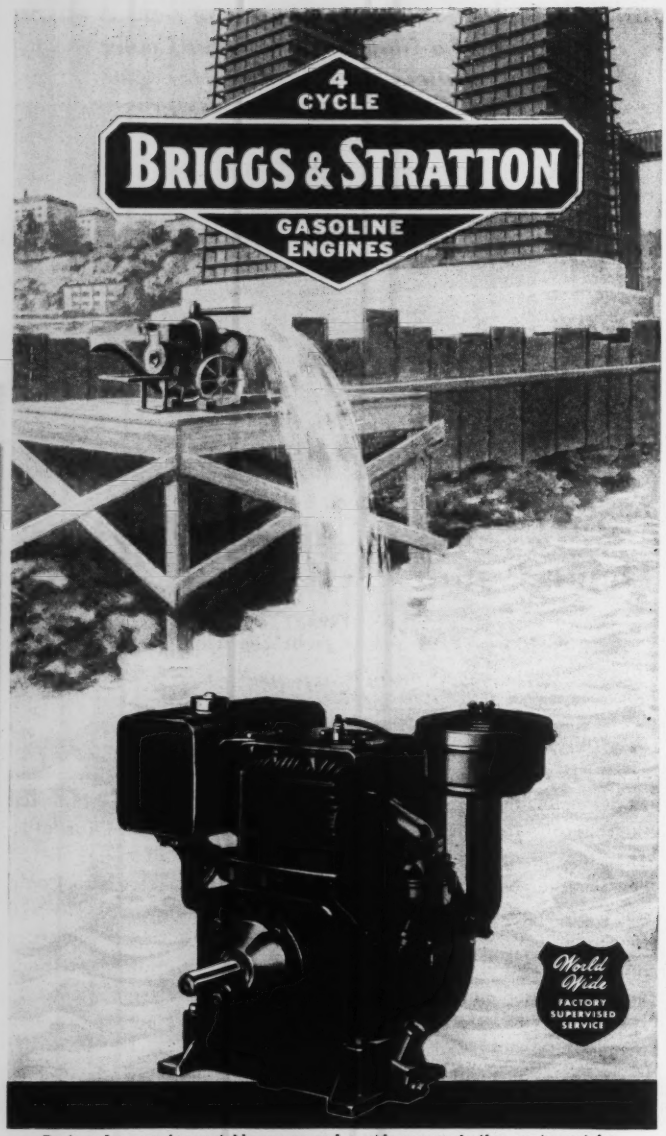
Experienced District Engineers in all Principal Cities



Preferred power for portable pumps and a wide range of other equipment for the construction industry — the world's most widely used single-cylinder gasoline engines on machines and tools for industry, construction, railroads, oil fields, etc., and on appliances and equipment for farm and home.

THERE are more Briggs & Stratton 4-cycle, air-cooled, single-cylinder engines in service than all other makes in their field combined.
Briggs & Stratton Corporation,
Milwaukee 1, Wis., U.S.A.

In the automotive field Briggs & Stratton is the recognized leader and world's largest producer of locks, keys and related equipment.

CATALOG GUIDE

197 VALVES

Ledeen Mfg. Co.—Recent Bulletin No. 510 describes a line of hand-operated, foot-operated, and finger or solenoid-operated valves for controlling the flow of air, oil, or water. Bulletin shows circuit diagrams and operation detail, dimensions and weights, and description of 14 models which are available in 6 sizes for 5 different cycles.

198 NAME-PLATE STAMPING

Acromark Co.—Folder illustrates and describes five practical ways of placing numbering and lettering on name plates, parts, and materials of metal, fiber, or plastic. Marking tools and machines such as steel letter and figure stamps, Hercules holders with steel type, hand and press style numbering machines, hand and foot-operated name-plate stamping machines, and hand and bench-type roll-marking machines are described. Power-press outfits for such marking, including slide and automatic feeds are also described together with photographs of results obtained by many leading manufacturers.

199 CENTRIFUGAL PUMPS

Byron Jackson Co. —Pump Div.—Bulletins describe individual BJ Pumps such as the submersible, deep-well, turbine, hydraulic press, boiler feed, vertical circulating, stuffing boxless, multiplex, process, sump, vertical propeller, pipe line, pneumatic sponge, double case hot oil, bulk station, sand and gravel, and other standard and special centrifugals. Other Bulletins describe special BJ engineered features such as the mechanical seal, double volute, etc. In addition Bulletins are available on BJ Pumps applied to specific markets such as irrigation, mining, milling, smelting, pulp and paper, and sugar industries. Most of the individual pump Bulletins contain assembly and construction detail drawings, installation photos, size, capacity, and other specifications and engineering details. Special engineering assistance is also offered on specific pumping problems.

200 EXPANSION JOINTS AND FLEXIBLE CONNECTORS

Zallea Bros.—New 60-page Catalog No. 47 on expansion joints and flexible connectors gives technical information on complete line. Full description of the manufacturing process and a discussion on selection of proper joints for any application are included. Profusely illustrated with charts and diagrams. A text book and reference source.

201 BUCKET ELEVATOR EQUIPMENT

Beaumont Birch Co.—New 6-page Catalog includes new Beaucalloy chains, Beaucalloy "Trac-Pull" wheels, Beaucalloy "Uni-Cast" bucket, and the Beaumont single-strand duplex bucket elevator.

202 HIGH TEMPERATURE STEELS

U. S. Steel Subsidiaries—Catalog gives a detailed discussion, supplemented with photographs, drawings, charts, and tables, covering the properties and characteristics of steels in high-temperature service.

203 ELECTROSTATIC CLEANING

Trion, Inc.—Designers and manufacturers of equipment for electrostatic cleaning and purifying of air or other gases offer Catalog Form E-22 as a convenient tool for engineers and industrial designers. Featured with all Trion equipment is the built-in washing system which makes it unnecessary for maintenance personnel to enter the ductwork to remove the collected dirt and impurities.

204 TAPER PLUG STRAINERS

Coen Co.—Manufacturers of Duplex Strainers for 35 yr describe their complete line of taper plug strainers and newly developed fabricated steel disc valve strainers for high pressures and temperatures in Bulletin No. 14-50. Four pages complete with illustrations and tables.

205 HORIZONTAL END SUCTION PUMPS

Peerless Pump Div.—Food Machinery & Chemical Corp.—Bulletin B-2300 describes complete line of horizontal and suction general-purpose pumps available in close-coupled electric and belted models. Handle capacities up to 5500 gpm and heads to 260 ft. Motor sizes are available from ¼ to 150 hp. Compact, efficient, durable, and versatile pumps for water and alkaline fluids.

206 ACTUATING CYLINDERS

Ledeen Mfg. Co.—Informative Bulletin No. 500, illustrates and describes complete line of actuating cylinders for air, oil, water, or steam operation. Bulletin shows detailed features, reasons for selecting medium-duty, heavy-duty or super-duty cylinders; dimensions and weights; ratings and limitations; rod and head attachments, and complete specifications. Bulletin is valuable guide to engi-

CATALOG GUIDE

neers, designers, maintenance men, and others whose equipment must push or pull, lift or lower, press or squeeze, tilt or turn, open or close.

207 GEARS, HERRINGBONE

Lufkin Foundry & Machine Co.—48-page Catalog G-1 covers complete line of standard herringbone gear speed reducers and increasers. Complete with Engineering Section, Horsepower Rating Tables, and General Dimensions. Single and double reduction slow and medium-speed units, also single-reduction high-speed units for pinion speeds of 3600 rpm and higher, are illustrated.

208 ELECTRIC HEATING UNITS

Edwin L. Wiegand Co.—Chromalox Industrial Electric Heating Unit Catalog 50 lists, strip, Finstrip, ring, and cartridge elements; oven and duct heaters; wide range of immersion and circulation heaters, all-metal infrared heaters, unit heaters, hot plates, thermostats, contactors, and hardware. Includes detailed specifications, uses, prices, and application data.

209 SHEAR-SEAL VALVES

Barksdale Valves—Catalog 1-B-1 covers the entire range of shut-off, selector, and manipulator valves for pressures from 0 to 6000 psi. Contains explanatory copy and illustrations of the patented "Shear-Seal" principle and a simple outline for determining proper valve size with tables giving steel pipe data and capacities of hydraulic rams.

210 SPEED REDUCERS

Cone-Drive Gears, Div. of Michigan Tool Co.—New 4-page engineering Bulletin gives basic general information on standard Cone-Drive speed reducers and gear sets ranging between 3-1 and 70-1 ratio, and from 0.05 up to 555-hp capacity. Standardization—for economy and easy service both of component parts and complete units—is emphasized.

Read the various items listed . . . one catalog may hold the solution to your present problem . . . select those items of interest to you by number . . . fill in coupon on page 44 and mail promptly.

211 BULK FLOW CONVEYORS

Link-Belt Co.—48-page Book 2175, copiously illustrated, contains complete engineering data on the combination Bulk-Flo elevator, conveyor, feeder, consisting of an endless chain to which cross flights are attached at intervals, all contained inside a close fitting casing. Ideally suited for handling a variety of bulk flowable granular, crushed, ground, or pulverized materials.

212 VIBRATION CONTROL

MB Mfg. Co.—Products for the detection, reproduction, and isolation of vibration are described in Bulletin 410. Booklet contains helpful design data on vibration control, plus information on Isomode pad, Isomode units, and details on MB vibration exciters and test equipment.

213 ELECTRIC MOTORS

U. S. Electrical Motors, Inc.—Electric motors in five classifications are featured in a series of five interesting Bulletins. These Bulletins present Varidrive motors, Syncrogear motors, Uniclosed motors, Sanitary motors, and Explosion-motors, with the products illustrated with natural color photos.

214 CENTRIFUGAL PUMPS

Pacific Pumps, Inc.—Centrifugal Pumps from A to Z—Bulletin No. 1 is four-page publication, giving the temperature, capacity, pressure, and head range for 29 different types of horizontal and vertical centrifugal pumps both single and multistage.

Continued on Page 68

THE HATHAWAY SC-16A SIX ELEMENT
RECORDING CATHODE-RAY OSCILLOGRAPH

NEW HIGHS IN RESOLUTION are obtained by this new oscillograph because of its unusually HIGH FREQUENCY RESPONSE and HIGH CHART SPEED...designed for recording fast transients and continuous phenomena.

FREQUENCY RESPONSE 0 to 200,000 cycles per second
RECORDS up to 1000 ft. long at speeds up to 600 inches per second
RECORDS up to 10 ft. long at speeds up to 6000 inches per second
WRITTING SPEED as high as 5,000,000 inches per second

Note these additional unusual features.

- SIX ELEMENTS with convenient interchangeable lens stages for 1, 2, 3, or 6 traces on full width of chart.
- INTERCHANGEABLE RECORD MAGAZINES for CONTINUOUS RECORDING on strip chart, either 6 inches or 35mm in width up to 1000 feet in length; DRUM RECORDING for short, high-speed records, and STATIONARY CHART for very short transients.
- PRECISION TIMING EQUIPMENT, tuning fork controlled, for 1-millisecond or 10-millisecond time lines.
- Crystal-controlled Z-AXIS MODULATION for 1/10 millisecond time marks.
- QUICK-CHANGE TRANSMISSION for instantaneous selection of 16 record speeds over a range of 120 to 1.
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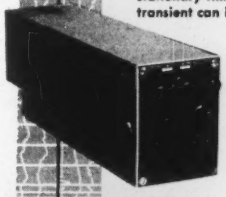
- CONTINUOUS SWEEP OSCILLATOR which permits viewing as well as recording.
- Single-pulse LINEAR OSCILLATOR for recording transients on stationary film. The record can initiate the transient to be recorded, or the transient can initiate the record.



Each recording element is a complete unit, fully housed, which can be instantly inserted or removed. Recording element contains high-intensity cathode-ray tube, and both AC and DC amplifiers. Control panel is located on outside end.

FOR FURTHER INFORMATION, WRITE FOR BULLETIN 2G1-K

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215 ELASTIC STOP NUTS

Elastic Stop Nut Corp. of America—Catalog No. 601—Elastic Stop Nuts, 90-pages, lists all standard ESNA self-locking nuts. Complete dimensional data with keyed index cross-referencing parts manufactured to AN Specifications. AN-ESNA conversion table, and a four-page list of all elastic stop nuts manufactured to AN Specifications are included.

216 OSCILLATING CONVEYORS

Link-Belt Co.—16-page Book No. 2244 contains layout drawings, selection charts, dimensions, and weights for the "PA" positive action, roller-bearing essentric-type oscillating feeder-conveyor. It is particularly recommended for handling sharp, abrasive, fine, lumpy, sticky, hot, or other difficult-to-handle materials.

217 BLUEPRINT MARKING PENCIL TEST KIT

American Lead Pencil Co.—Kit contains samples of new Venus unique colored pencils for marking on blue or white prints. 54 per cent stronger—sharpens to a sharp needle point and holds it. 27 per cent greater markability—brilliant clear marking—waterproof.

218 TECHNICAL BOOKS

The American Society of Mechanical Engineers—1951 Catalog of ASME Publications. A 20-page descriptive price list of current books, standards codes, research reports, and periodicals published by the Society.

219 TUBE FITTINGS

Parker Applicance Co.—Catalog 203 describes Parker industrial tube fitting in all current types, sizes, shapes and material. This catalog also includes a section on tube fabricating equipment, information on flaring tools, tube cutters, hand tube benders, and bench-mounted tube benders.

220 TEMPERATURE AND PRESSURE REGULATORS

Fulton Sylphon Div.—Robertshaw Fulton Controls Co.—Well illustrated Catalog A describes the Fulton Sylphon line of regulators for temperature and pressure control. This catalog also gives technical information relating to relief valves, pump governors, safety and vacuum regulators. In all there are over 200 pages of illustrations, data, and drawings.

221 FLEXIBLE COUPLINGS

American Flexible Coupling Co.—Newly designed American flexible couplings are described in Catalog No. 501, along with dimensional and operating information. The unique design of the faces of the hub teeth which are chamfered to eliminate interference with the sleeve teeth fillets to allow the true involute flange of the gear to be in contact, reduces tooth wear to a minimum. Backlash can also be controlled to 0.004 in. All Amerigear couplings are parkerized for longer life.

222 TRACING PENCIL TEST KIT

American Lead Pencil Co.—Kit contains samples of Venus tracing pencils for testing on various types of papers. This new pencil contains an active chemical to produce clearer, sharper, white or blueprints when reproduction is made from a pencil drawing.

223 OIL SEALS

National Motor Bearing Co., Inc.—New Catalog No. 102 gives complete listings of stock sizes and designs of National Oil Seals.

224 DUST COLLECTORS

Prat-Daniel Corp.—Prat-Daniel Tubular Dust Collectors—Valmont Type "S" and Standard Type H-C. This Bulletin describes new developments in tube design that increase efficiency through improvement of the size and shape of the inlet aperture so as to admit incoming gases in the shape of a deep, narrow ribbon. This reduces the distance the dust particles travel before coming in contact with the precipitating wall, and results in greater collection efficiency. Bulletin also contains details for using mechanical collectors in series with electrostatic. Bulletin No. 250-S.

The "Buyer's Catalog Guide" offers readers of MECHANICAL ENGINEERING an opportunity to secure advertisers' latest industrial literature available. In this issue there are 224 items to make selections from. For convenience an index may be found on pages 43 and 44. Select desired catalogs by number, fill in coupon on page 44 and mail promptly. *(Must be mailed on or before date given on coupon.)*

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1 Rigid one-piece construction—easy to install.
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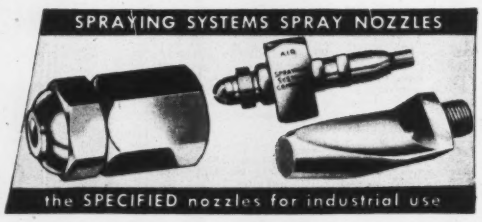

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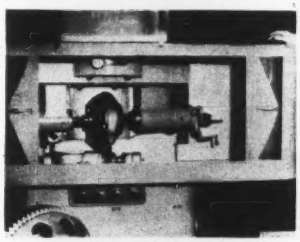
• NEW EQUIPMENT

Tractor Gear Production



More and more, mass-production methods are being adapted to job-lot or shorter-run production of miscellaneous parts in order to increase output per machine and man-hour. Typical is the manufacture of gears and tractors at Caterpillar Tractor Co.

For example, one Shear-Speed gear shaper can turn out anywhere from 45 to 60 tractor gears per hr and can be used for interchangeable production of 11 different gears at Caterpillar. Eight of these gears are used in one transmission. Nine of them—with duplications of course—in another transmission. Average changeover time is one hour when the complete cutter head is removed. When it is necessary only to change the blades in the head, changeover time is cut to only 35 minutes.

A Michigan 870 Underpass gear shaving machine is used in the production line producing replacement, experimental, and timing gears. A modified underpass movement is used on this machine, shaving of the timing gear shown being at the rate of 14 gears per hr, although the gears are prehardened to 363 Brinell before shaving. Short changeover time is of course an important characteristic.

Solving Bearing Problems

An Arkansas bearing expert who plugged a few holes and thereby saved an aluminum company a lot of money is the recipient of the first incentive award in a contest being held by SKF Industries, Inc., Philadelphia, Pa., among its industrial distributors.

He is M. M. Tompkins, general manager and secretary-treasurer of the Allied-Arkansas Bearing Co., Little Rock, Ark., whose simple expedient was responsible for making ball bearings last for months instead of weeks.

The monthly incentive awards for the best solution to a bearing problem are part of an educational campaign designed to enable SKF's industrial distributors to extend their range of service to customers as qualified anti-friction bearing specialists.

Tompkins, who has been identified with the bearing industry since 1929, was called in by the aluminum plant because of repeated failures of bearings in a carrier conveying alumina, from which aluminum is made.

The fine metallic powder, he discovered, was entering the unshielded bearings through grease holes. When grease was added, which was frequent, the alumina that had collected around the fittings was pumped into the bearings and their shafts.

Tompkins recommended the use of bearings with double seals to keep out alumina and also the removal of the grease fittings. The holes left by the fittings were plugged and grease packed around the outside of the bearings so as to "trap" any alumina that found a way into the bearing housings.

G-E Hi-Thoria Tungsten Reduces Inert-Arc Welding Cost

A new tungsten electrode which will reduce inert-arc welding costs has been announced by the General Electric Company's Welding Divisions, Fitchburg, Mass.

Major applications of the new tungsten will be for inert-arc welding with direct current, straight polarity using either argon or helium gas. This type is usually used to weld mild steel, stainless steel, copper, and *alloys*, G-E engineers said.

The new Hi-Thoria tungsten electrodes will produce a stable arc over a wider range of currents and will resist contamination by weld metal, according to the engineers, resulting in over ten times normal life. Hi-Thoria tungsten has strength comparable to standard pure tungsten.

The end of a standard tungsten electrode when subjected to arc temperatures tends to become molten and forms a round shiny surface. The molten surface sputters off into the work in relatively large quantities on arc starting and in minute quantities from time to time when welding, so that the tungsten is slowly consumed, G-E engineers explained.

Hi-Thoria tungsten, however, runs cooler than standard tungsten and does not become molten. The end remains square and

Continued on Page 70

All These Were Once

DUST COLLECTION PROBLEMS, TOO

48 Carbon Black Plants
203 Metallurgical Installations
205 Acid Plants • 40 Paper Mills
270 Detarring Installations
216 Power Stations
73 Steel Plants • 99 Oil Refineries
and Miscellaneous Installations

Your electrical precipitator installation will be individually engineered...and based on the Research Corporation's *experience* graphically shown by that towering pile of thousands of blue prints.

This knowledge is a valuable asset that will help Research engineers to "tailor-make" your Cottrell installation. For example, they can more quickly determine the right answers to such variables as the size, shape and type of both discharge and collecting electrodes, their relative spacing, flue arrangements and many other factors. At Research you can count on *profitable solutions to individual problems.*

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- **Protect piping against strain, stress, settling, shock, or vibration! Excellent for outside service piping connections to buildings, large storage tanks.**

COMPLETE LINE—15 different sizes, ¼" to 12". Angle or straight, male or female threaded connections—flanged connections—welding ends for welded connections. Available in materials suitable for temperatures from −50° to as high as 1,000° F.; for pressures from vacuum to 750 p.s.i. steam, or 6,000 p.s.i. hydraulic. Fire-proof, pressure-safe! Standard throughout the world—available through leading supply companies.

ENGINEERING RECOMMENDATIONS—Barco factory and field engineers are ready to help you solve your problems. ASK FOR NEW CATALOG NO. 215 "BARCO FLEXIBLE BALL JOINTS."

BARCO MANUFACTURING CO.
1821 E WINNEMAC AVE. CHICAGO 40, ILL.
The Only Truly Complete Line of Flexible, Swivel, and Revolving Joints
FREE ENTERPRISE—THE CORNERSTONE OF AMERICAN PROSPERITY

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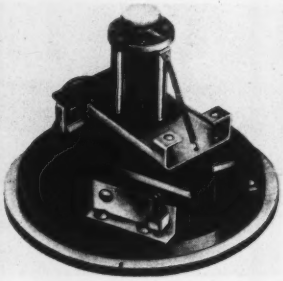
intact and consumption is reduced. According to the engineers, it is seldom necessary to stop welding in order to clean or break off the end of the electrode. The arc tends to stay under the electrode and will not wander or climb up the electrode at low currents, assuring consistent ease of operation. Touch starting is easily accomplished with currents as low as 5 amperes. The new electrode is manufactured in three to twenty-four inch lengths and from .040 to 1/4 inch diameter.

Hi-Thoria tungsten is not recommended as a standard tungsten replacement for reverse polarity d-c, a-c welding, or atomic-hydrogen welding.

Surface-Type Thermoray

Sarcotherm Controls, Inc., New York, N. Y. announce the new surface type Thermoray, designed to function according to effective temperature, and is an important part of the Sarcotherm control system for hot water radiant heating. It can also be used effectively for controlling electric radiant heating panels.



The instrument can be used for line or low voltage circuits, and can be furnished with double switch action for any special control sequence required.

Recirculation Steam Generator

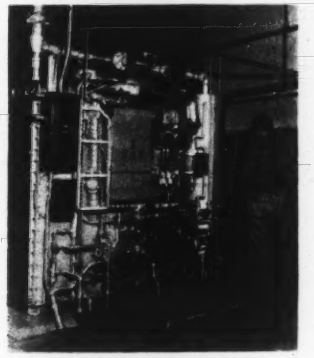
A compact, reliable steam plant culminating a five-year period of research, development, and operating experience is now being offered by Combustion Engineering-Superheater, Inc., New York, N. Y. Known as the "C-E Recirculation steam generator," it is actually a complete steam plant which includes feedwater pump and control, fuel equipment and control, combustion control and safety devices, forced-draft fan, safety valves, circulating pump, and all other auxiliaries. The generator may be fired by light or heavy fuel oil or by natural gas. It is available in several sizes for steam capacities from 2800 up to 6000 lb per hr and for operating pressures up to 300 psig.

The C-E Recirculation steam generator was originally developed for train heating service and for more than five years these steam generators have been tried out in regular operation on major American railroads, more than 200 being in service at the present time. Their performance has been proved under extreme conditions of heat and cold accompanied by the jarring and vibration of locomotive service.

Initial applications in industrial and institutional plants were made early in 1950. These were reported highly successful and since then a number of generators have been purchased for such various types of service as space heating; processing of tobacco, chemicals, cotton fabric, asphalt, dairy products,

and paper products; space heating in a central station when utility boilers are not operating; process steam for pickling vats, vulcanizing rubber, and plating die castings; and heating stills.

The experience obtained in these installations has demonstrated that the generator is particularly applicable where one or more of the following conditions apply: where high-pressure steam is required in relatively small quantities; where steam is required in remote locations, normally involving the expense of installing and maintaining long insulated pipe lines; where demands are intermittent—a few hours each day or week; where an occasional emergency load may exceed the capacity of existing boilers; where load is highly fluctuating and involves sudden heavy demands necessitating fast pick-up; where completely automatic operation with a minimum of attention is necessary or desirable; where space is a problem or where maximum output from minimum space is desired.



A notable feature of the generator is its compactness. The 6000-lb-capacity unit for burning light oil or gas occupies a space 6 ft 11 in. long × 5 ft 5 in. wide × 6 ft 11 in. high, and the heavy oil-burning unit is only slightly larger. Compared to small conventional water-tube boilers of modern design or present-day package-type fire-tube units, the generator will produce 3 to 4 times as much steam per cubic foot of space occupied.

The feature that distinguishes this generator from all other types of small steam generators is the use of the controlled recirculation principle. The high rate of heat transfer made possible by the use of this principle permits maximum steam production per unit of heating surface and thus makes possible maximum steam output per unit of space and weight. Moreover, controlled recirculation assures positive circulation throughout all heating surfaces, virtually eliminates scale formation and permits higher operating efficiency.

Savings at National Malleable Through G-E Electric Furnaces

The National Malleable & Steel Casting Co. of Cleveland, Ohio, large-scale manufacturers of malleable castings for the railroad and automotive industries, has achieved substantial savings through the use of General Electric annealing furnaces.

Five furnaces have been installed, three of

Continued on Page 72

Fig. 3169 single stage, open impeller centrifugal

Goulds *New Design*

gives carefree pumping efficiency for the long pull

The 3169 is one of the latest designs to come off Goulds drawing board. It takes every advantage of modern hydraulic design—and it is thoroughly tested and proven for economy and dependability.

With the 3169 you get tremendous versatility with high operating efficiency and relatively low power consumption.

REAL "JACK-OF-ALL-TRADES" ADAPTABILITY

This new pump will fit many applications—water service, irrigation, slurries, circulation, transfer, factory wastes, air conditioning service, plumbing, heating, and many others. If you face conversion, this adaptability is a double value.

TEN SIZES TO FIT YOUR NEEDS

Available in ten sizes for both motor and belt drives. Capacities up to 1080 G.P.M.—with heads to 290 ft. depending upon capacity.

For complete information phone or write Pump Headquarters, Seneca Falls, N. Y. Ask for Bulletin 720.4.

MEMBER

Goulds PUMPS INC. Seneca Falls New York

How to keep Line "FEATHERS" out of your hair !

It was a clean, sharp line till it had to be erased. But when it was re-inked, brother how it feathered and "blobbed"!

Feathering lines are one of the things you *don't* have to worry about with Arkwright Tracing Cloth. Even erased surfaces will take a neat, sharp line. What's more, you'll never find pinholes, thick threads or other imperfections in Arkwright cloth. You'll never have to fear that your drawings will discolor, go brittle or become opaque with age. A drawing on Arkwright Tracing Cloth will yield clean, clear blue-prints years after you make it.

Aren't your drawings worth this extra protection? Arkwright Finishing Co., Providence, R.I.

ARKWRIGHT *Tracing Cloths*

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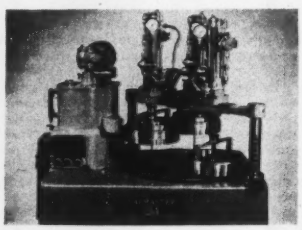
which are high temperature annealing furnaces, rated at 390-kw, 460 volts, 3 phase, 60 cycle, maintaining a temperature of 1800 degrees F; and two are low temperature drawing furnaces, rated at 230-kw, 460 volts, 60 cycles, with a maximum operating temperature of 1300 degrees F. Each of these furnaces has a five-ton capacity load.

Each furnace is controlled by an electrical control system, designed for special application to the malleable casting industry, and may be shut off independently by a master switch, without affecting the other furnaces in the bank. Each furnace has separate controls that regulate and keep constant the heat on the side of the furnace. An identical control equally regulates roof heat so that uniform heat is assured throughout the furnace, and a high quality of annealing results.

In electrifying the operation of these furnaces, National Malleable has shortened the time cycle involved in producing castings. Two G-E electric cranes are combined to reduce the operation of either loading or unloading to single co-ordinated efforts. A gantry-type crane, operating on tracks running parallel to the bank of furnaces carries loads to each furnace. From this crane's control cab, the operator activates a crane hoist, situated above the furnaces to lift the furnace being loaded. Next, the load is moved forward underneath the furnace and set on supports. The furnace is then lowered to its base and, by means of a sand seal, forms an air-tight chamber, thereby providing an atmosphere control and contributing to the reduction of scale on a heated metal.

In addition to the reduced production time cycle and the higher quality resulting from this change to electric heat, National Malleable has realized other economies and advantages. The high expense involved in the use of annealing containers has been limited. Better working conditions and substantial savings in floor space have resulted. Replacement of heating units and other maintenance expenses has been reduced to an estimated 40 per cent below those of fuel-fired furnaces. Consequently, expansion plans at National Malleable and future developments in their production system, involve still further use of electric heat.

Speed Lapmaster Attachments



Two special standard attachments for the Crane Packing Co., Lapmaster enable users to speed production and simplify handling of certain types of parts. These developments, the roller bar attachment and pneumatic lifts, were recently introduced by the company to bring a wider range of work to the point of practicality in lapping.

In the Lapmaster principle of operation, parts are held inside inexpensive micarta workholders which fit into conditioning rings. These rings float on the lapping plate, and revolve on their own axis from the action of the rotating lap plate. Their function is to

hold the work, and at the same time, continually condition the lap plate during machine operation—thus completely eliminating down time for dressing of the plate surface. Properly engineered compound-vehicle mixture is continuously agitated in a mixing tank, and flows automatically to the plate throughout the lapping cycle.

In the standard Lapmaster models, the conditioning rings are adjusted to maintain flatness of the plate by means of an overhead "spider-bar" arrangement. This allows sufficient clearance for easy and rapid loading and unloading of the work.

The roller bar attachment was designed primarily to facilitate loading and unloading of tall or large parts. Instead of the overhead spider bar, it makes use of brackets mounted outside the circumference of the lap plate. Elongated slots allow adjustment of these conditioning ring holding brackets. Complete accessibility of the lap plate is afforded with this arrangement—height of parts is unlimited and in most cases, large heavy castings lap of their own weight.

When large numbers of small parts must be lapped, the pneumatic lift attachment will speed production by facilitating loading and removal of parts and workholders. Each conditioning ring and pressure plate unit is individually raised by a pneumatic lift. When the automatic lapping cycle stops, each lift is quickly raised by pneumatic pressure, lapped parts removed, and preloaded workholders placed in position—all with a minimum of time. The pneumatic lift eliminates more than ⅔ the handling costs when large numbers of parts must be lapped.

These attachments, and all Lapmaster models ranging in size from 12-in-diam lap plates up to 72 in. are described in new 16-page catalog, furnished free by Crane Packing Co., Chicago, Ill.

• LATEST CATALOGS

Aircraft Electrical-System Book Announced by Westinghouse

Assistance to operators and designers of large-aircraft alternating-current systems is offered by Westinghouse Electric Corp. in a new 70-page book.

Pointing out the potential displacement of direct-current by alternating-current systems in large aircraft, the book provides latest design requirements, maintenance hints, and uses of these a-c systems.

As an expanded second edition, it includes: a new transformer chapter; data on a-c fuses and power cable; an up-to-date chapter on circuit breakers and relays; and a chapter covering importance of variable-frequency systems for radio, radar, window-heating, surface de-icing, lighting, and galley loads.

The book stresses special application problems inherent in high-altitude operations, and provides a general discussion of aircraft-type a-c generators and motors, driving mechanisms, and distribution systems.

Alternating Current Electrical Systems for Aircraft (R-1064-A) is available for $1.50 from Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Penna.

Steel Flooring Catalog

A new catalog describing various types of open steel flooring and armoring is available from the Machinery Div. of Dravo Corp., Pittsburgh, National Distributors for the Tri-Lok Co.

The catalog, No. 1103, discusses the different types of Tri-Lok open steel flooring and safety treads. It contains specification data, safe load tables, installation methods and other pertinent information.

Also included is descriptive information on Tri-Lok Floor Armoring and T-Tri-Lok Flooring. T-Tri-Lok Flooring, an assembly of Tee Bars, when filled with concrete, is used instead of heavy concrete flooring reducing the dead load and thus permitting a lighter weight superstructure.

This catalog can be obtained by writing Dravo Corp., Machinery Div., National Department, Fifth and Liberty Aves., Pittsburgh 22, Pa.

New G-E Manual of Watthour Meters Covers Fundamentals of Alternating-Current Metering

A new Manual of Watthour Meters which comprehensively covers the fundamentals of alternating-current metering has just been announced by the General Electric Company's Meter and Instrument Divisions.

Fully illustrated with charts, diagrams and photos, the 40-page brochure shows how electric energy is measured; describes the operating principles of alternating-current watthour meters; and explains the techniques involved in the use, the testing and maintenance of meters.

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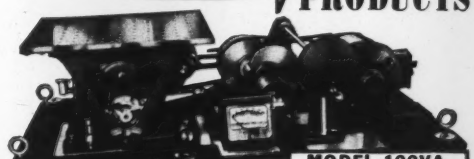

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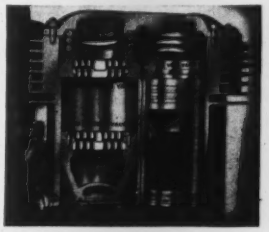

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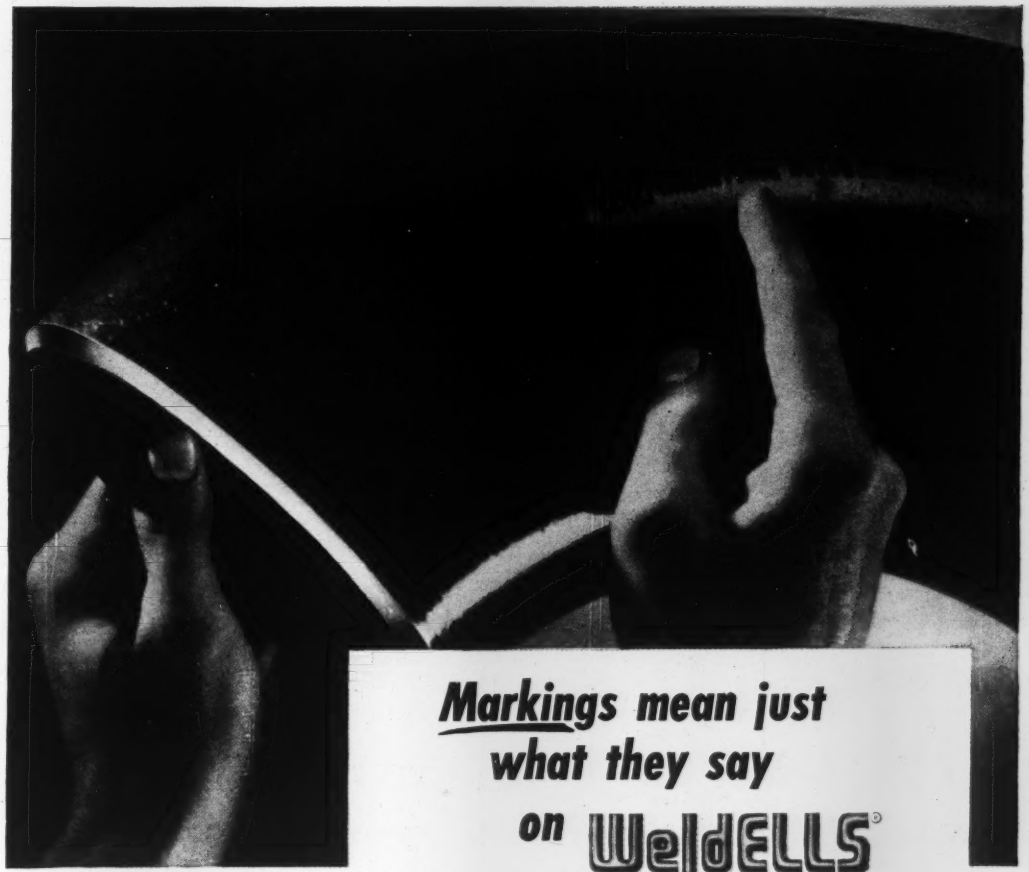

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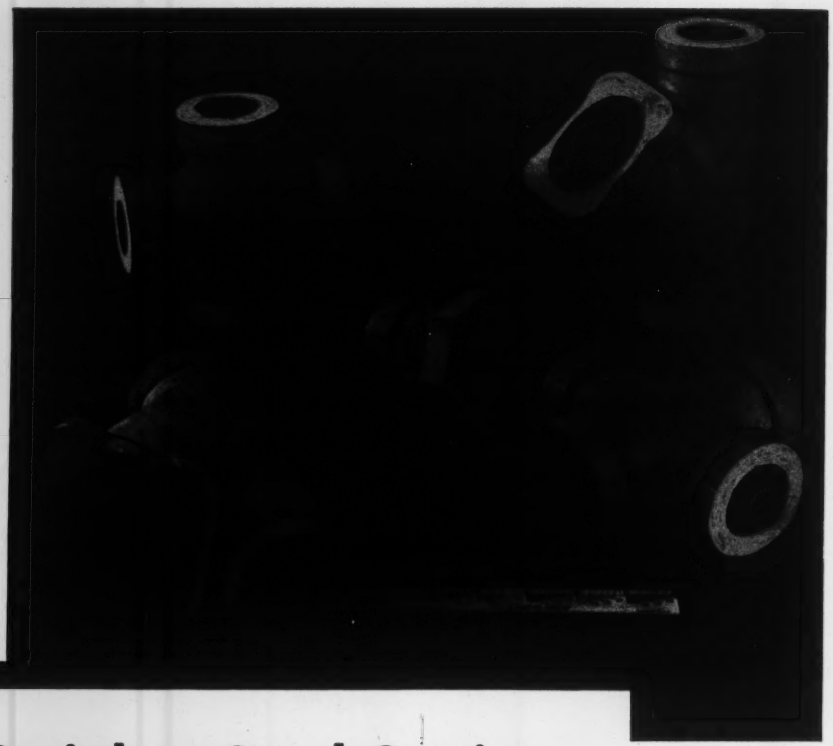

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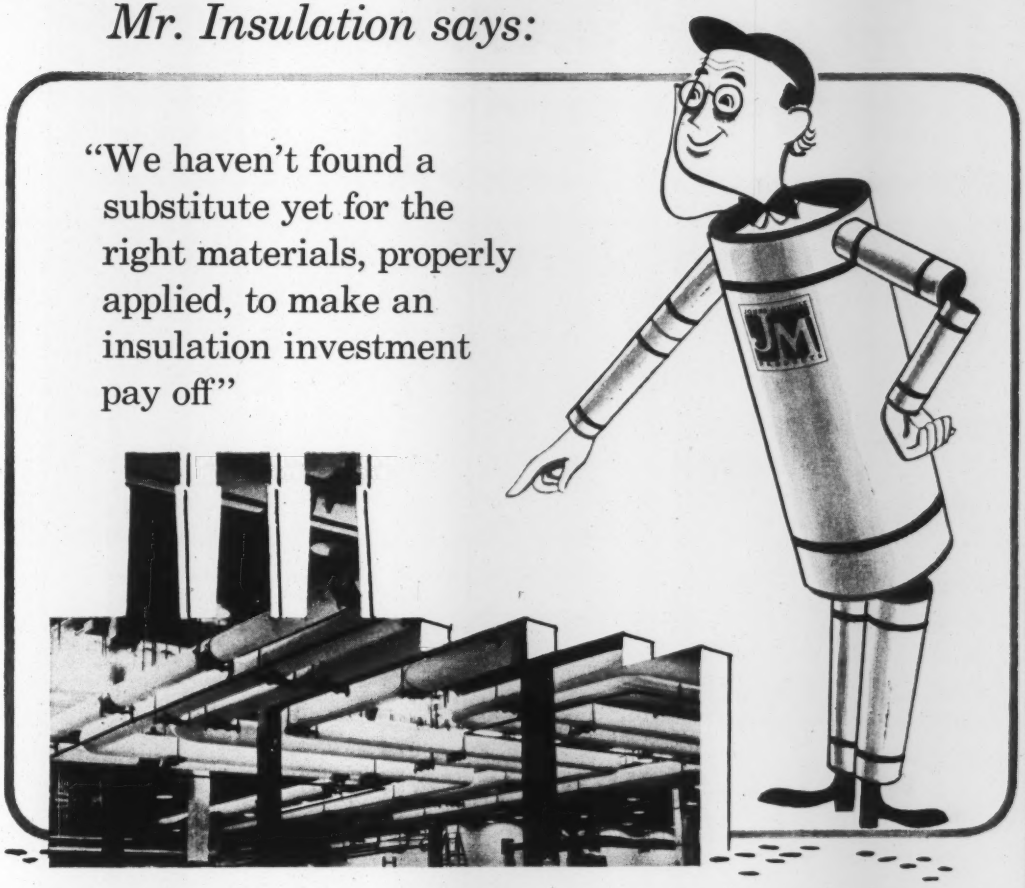

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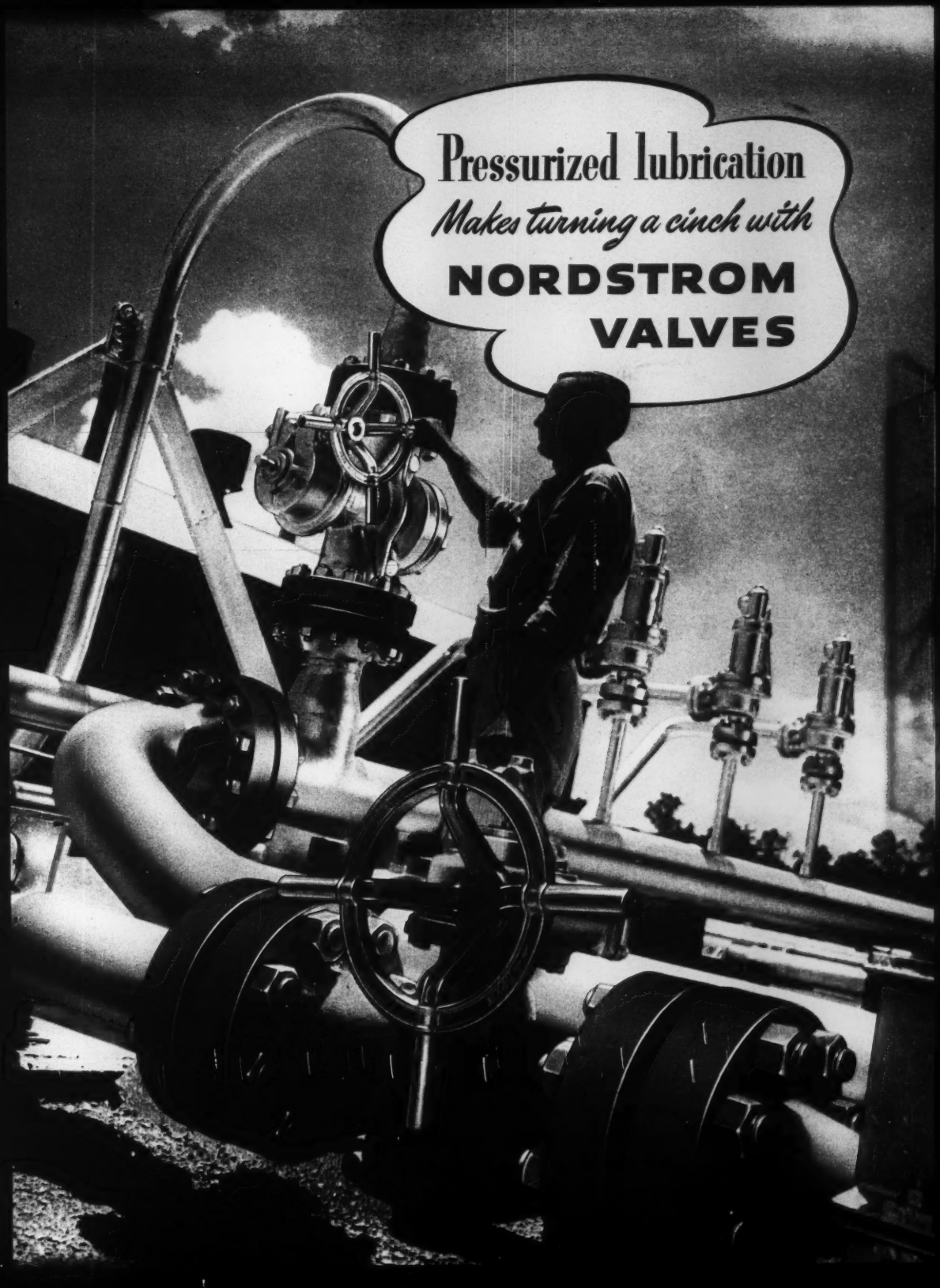
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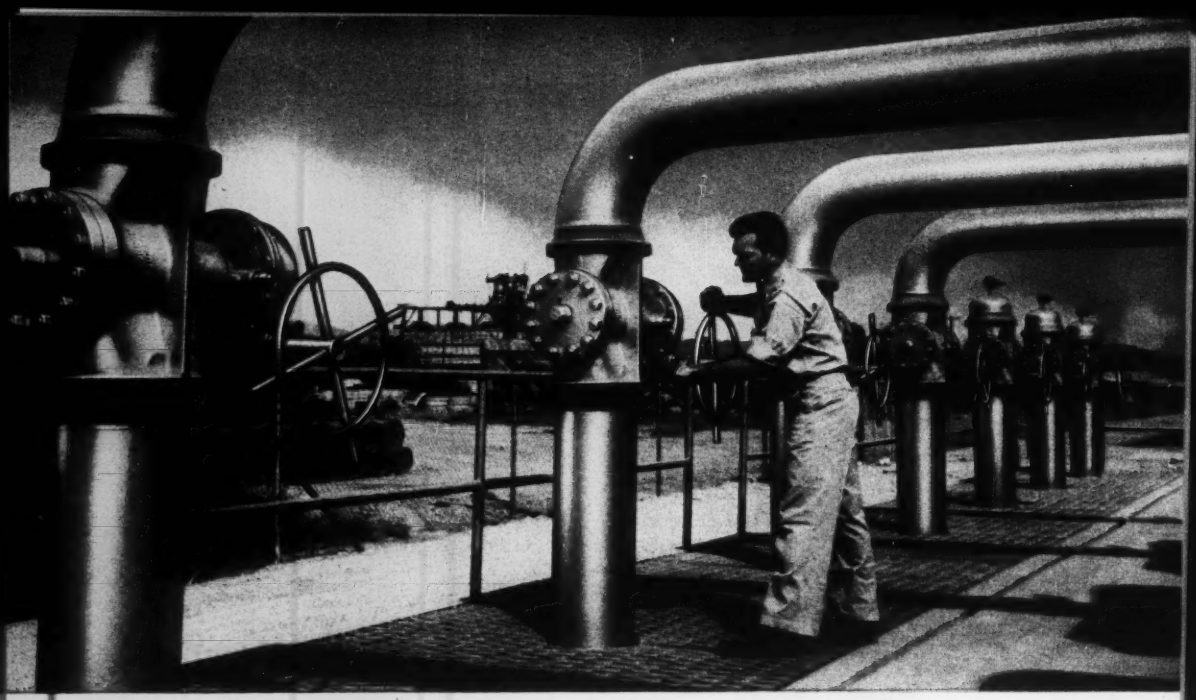

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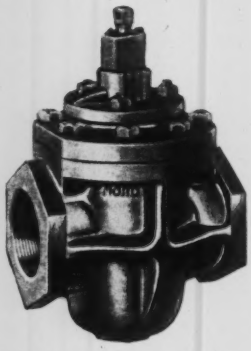

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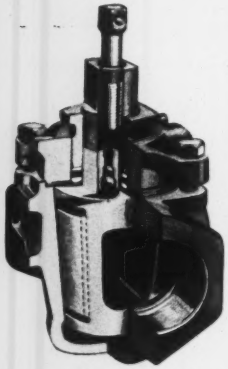

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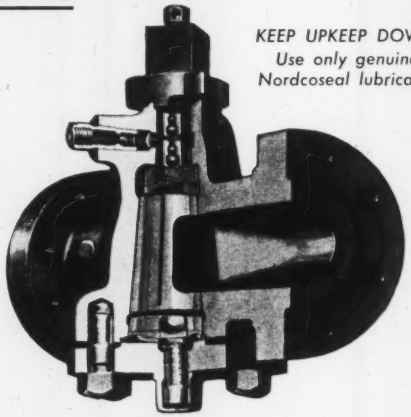

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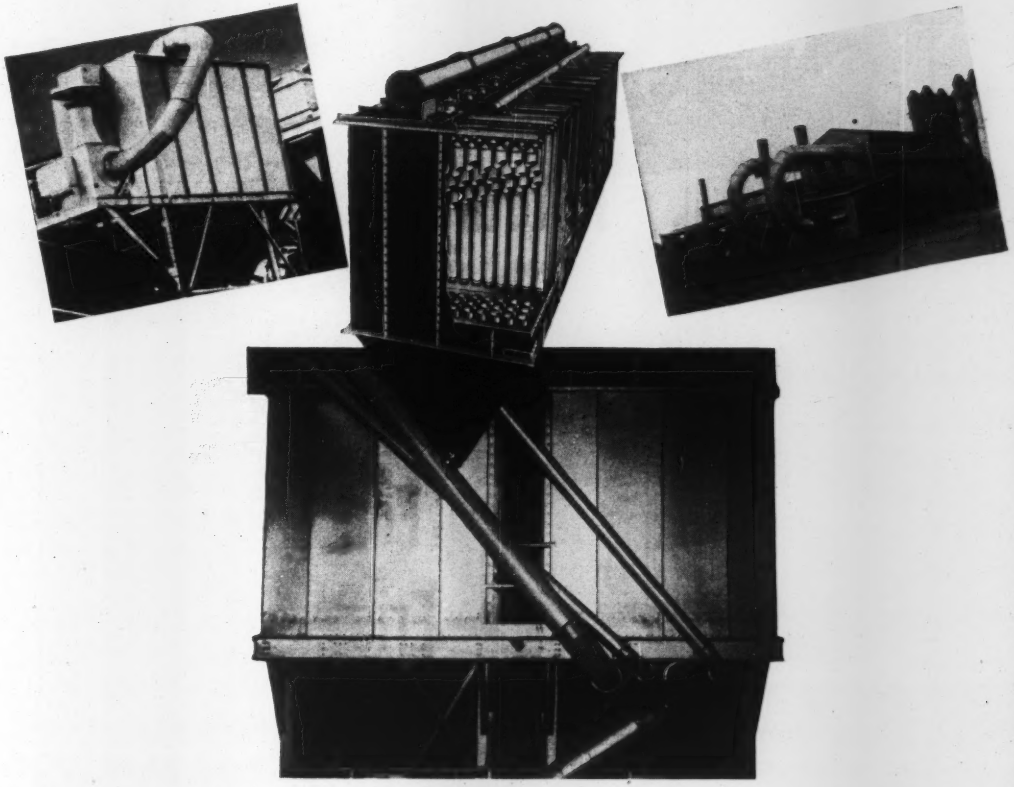

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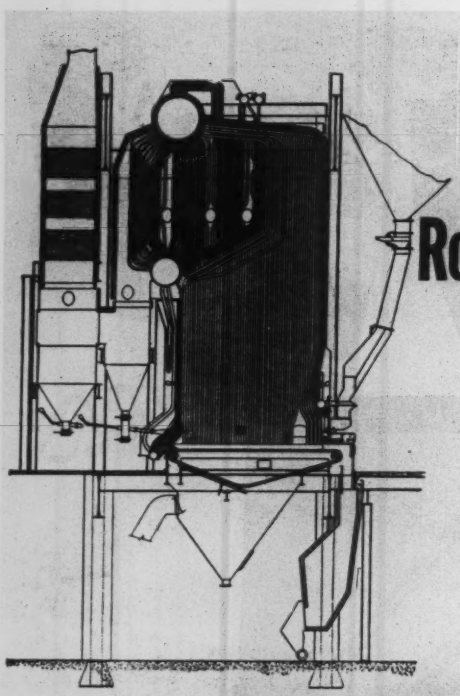

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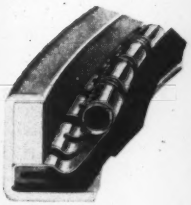

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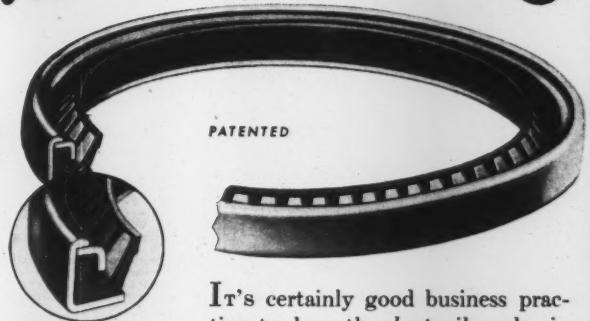

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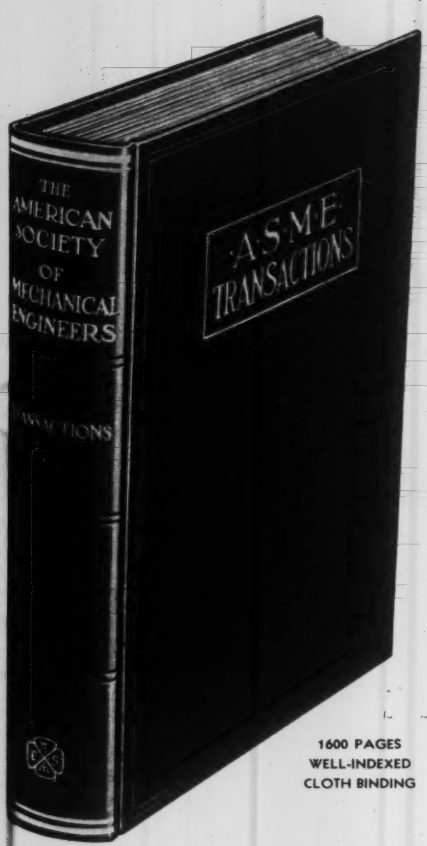

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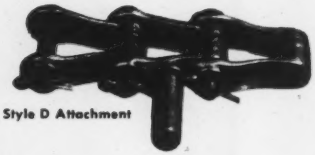

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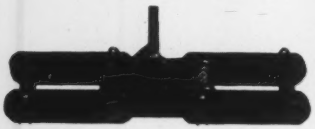

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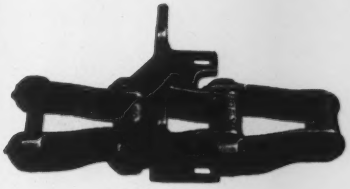

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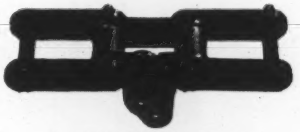

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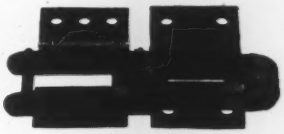

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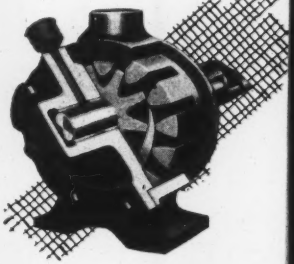

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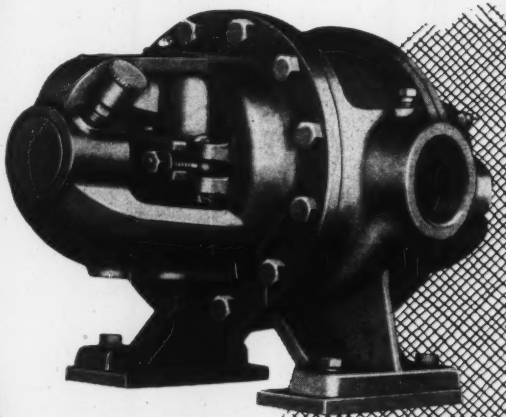

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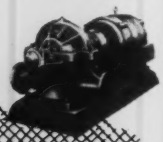

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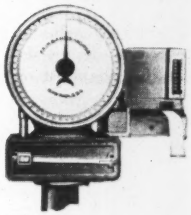

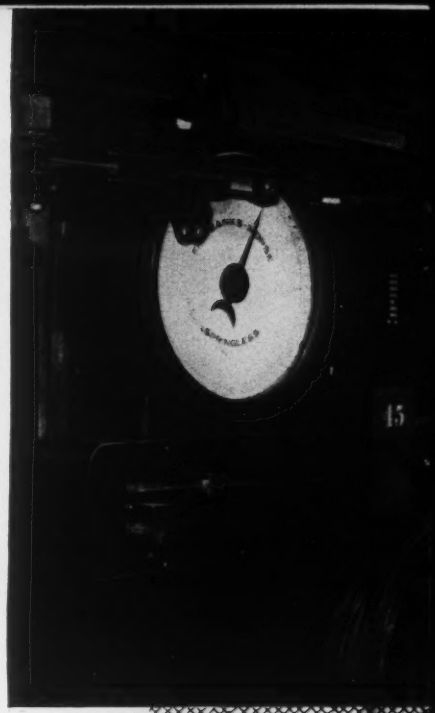

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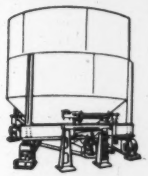

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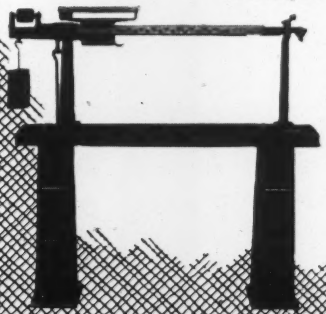

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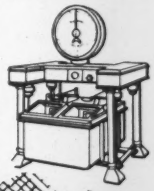
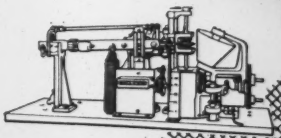


Weigh Can Scale



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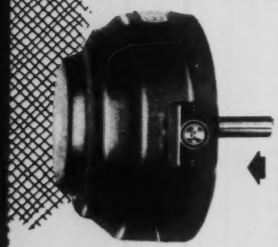
with Copperspun Rotors!

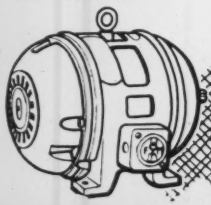
Here are a few in the complete Fairbanks-Morse line



GENERAL PURPOSE, drip-proof motors mountable in any position with full protection against flying chips, falling particles, dripping liquids, etc.

AXIAL AIR-GAP MOTORS: Averaging 30% lighter and 40% shorter overall—with flywheel effect three times that of corresponding ratings of conventional motors. Add to appearance, decrease size and weight of any driven machine. Meet all AIEE and NEMA standards.

TOTALLY ENCLOSED FAN-COOLED motors operate economically, safely under adverse conditions, including corrosive gas, vapors, steam or where metallic particles, abrasive dust and/or other materials are in the air. Available with Underwriters labels for use in Class 2, Group G hazardous locations.



FOR THESE EXCLUSIVE ADVANTAGES

Compare!

The Fairbanks-Morse Copperspun rotor design shows up at its best under comparison. It contrasts the mechanical strength and superior electrical characteristics of copper—against the poorer showing of aluminum and other white metal alloys. It contrasts new standards for uniformity and strength made possible through its precisely controlled centrifugal casting—against the results obtainable through standard, even old-fashioned, manufacturing procedures.

Finally, comparison drives home the virtues of indestructibility, homogeneity and high electrical efficiency. That means more satisfactory operation of motors with the Fairbanks-Morse Copperspun rotor.

ONLY COPPERSPUN ROTOR OFFERS THESE ADVANTAGES:

- ★ A truly one-piece indestructible copper rotor winding.
- ★ Withstands higher temperatures: (melting point 2,000° F. for Copper, 1,100° F. for Aluminum)
- ★ High electrical and thermal conductivity.
- ★ Dense, uniform grain structure.
- ★ Separately mounted fans: permitting complete overall machining, better quality control, better dynamic balance.

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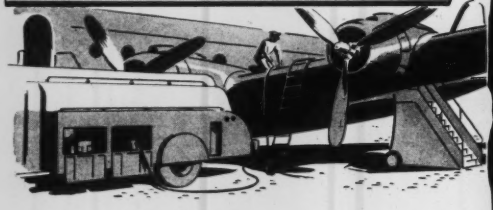

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EASIEST TO UNDERSTAND INSTALL, OPERATE AND MAINTAIN

Add to these features the exceptional dependability and long life provided by Peerless' vertical, close coupled, turbine pump construction and you have adequate reasons for the complete acceptance of these pumps for both military and commercial airfield or shipboard installation.

WRITE FOR PEERLESS PUMP BULLETIN No. B-2522 and sample specifications today. This detailed and descriptive information will save you time and money in planning approved-type gasoline and fuel oil transfer pumping installations.

Characteristics at a glance:

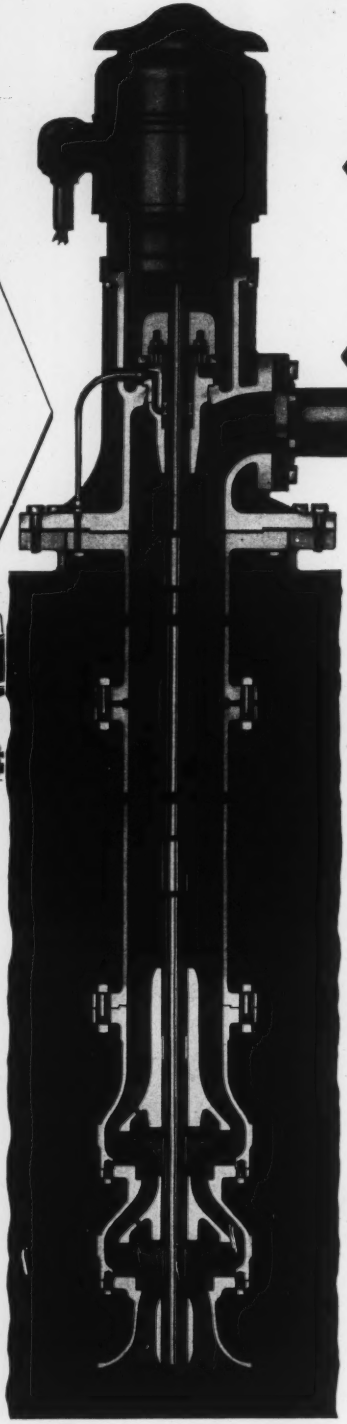
HEADS: From 20 to 300 feet.

CAPACITY: 30 to 1500 gallons per minute.

HP RANGE: 2 to 75 hp.

DRIVES: As required; standard, vertical, electric hollowshaft, explosion proof motor or right angle gear drive for use with stationary engines.

LUBRICATION: Open line shaft construction; nonmetallic bearings lubricated by liquid being pumped.



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Underwriters' Approved Construction Throughout

Specially IMPREGNATED PACKING
Port relieves pressure and drains seepage to sump

(Illustrated)
AIRFIELD TYPE DISCHARGE BASE
(Shipboard type uses flanged deckplate)

BEARINGS LUBRICATED BY LIQUID PUMPED

NO PRIMING PROBLEMS

FLANGED TYPE CONSTRUCTION FOR UTMOST RIGIDITY

ENCLOSED IMPELLERS ASSURE MAXIMUM EFFICIENCY

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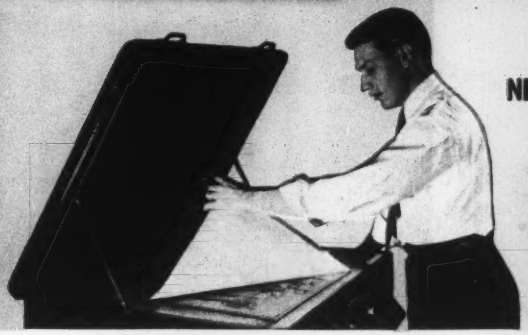

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Eliminate Costly Retracing

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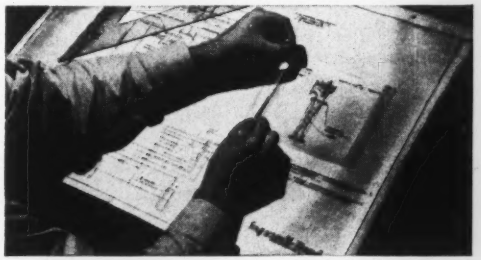
"Ink quality" file copies of pencil drawings are produced with Kodagraph Autopositive Cloth

Instead of making expensive "ink on cloth" tracings of its original drawings, Ingersoll-Rand simply reproduces them on Kodagraph Autopositive Cloth. This new photographic material produces positive copies *directly* (like Kodagraph Autopositive Paper and Film) . . . without the negative step . . . without darkroom handling. No special equipment is required, either: a photocopy machine is used for the exposure operation . . . standard photographic solutions for development. *Result:* intermediates that have the sharpness, the sparkle of new ink tracings . . . with non-smudging, dense photographic black lines on a durable white cloth base.

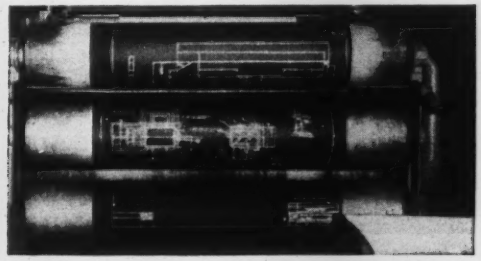
Old, soiled, or damaged drawings are restored with Kodagraph Autopositive Paper

When such drawings are taken from the files, the call is for Kodagraph Autopositive Paper—to eliminate hours of expensive retracing time. This low-cost, high-contrast photographic material increases line density . . . cleans up backgrounds . . . in many cases delivers serviceable intermediates that require no handwork at all. Drawings in very poor condition are restored by Ingersoll-Rand in the following manner: after an "Autopositive" is made, stains, creases, and other unwanted elements are removed with eradicator fluid or razor blade. Then, the print is used to produce a second "Autopositive," which is touched up with pencil if necessary.



Standard units are added to new drawings with Kodagraph Autopositive Film

Among the many ingenious drafting short cuts developed by Ingersoll-Rand is the use of Kodagraph Autopositive Film overlays made from standard-component drawings. These transparencies are kept on file . . . and taped to new drawings whenever necessary. Following this, the composite is reproduced on Autopositive Paper. *Result:* a photographic intermediate of uniform line density . . . plus important savings in drafting time.

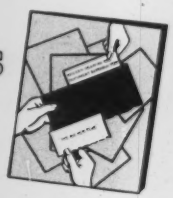


Additional advantages of using Kodagraph Autopositive intermediates

Sharper, cleaner blueprints are produced—at uniform, practical speeds—because Ingersoll-Rand makes them from "Autopositives" instead of its perishable original drawings. This way—there's far less chance of "reading errors" in the shop. And valuable originals are protected against machine wear and tear . . . constant handling; are kept safe in the files available for reference and revisions only.

Kodagraph Autopositive Materials

"The Big New Plus" in engineering drawing reproduction



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She SINGS . . . *She* LAUGHS

She TALKS . . . *She* PRAYS

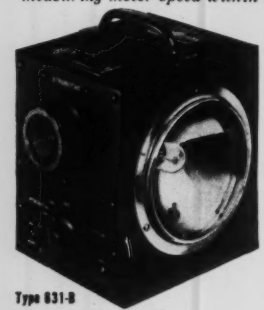
. . . all because of the STROBOTAC®

This Effanbee Doll, manufactured by a division of the Noma Electric Company, is the pride and joy of thousands of little (and big) girls. She is made vocal by means of a very cleverly designed, "built-in" talking machine, the heart of which is a miniature electric motor which operates on 2 standard flashlight batteries.

The batteries, motor, small phonograph turntable, minute record, pick-up and loudspeaker are housed in a plastic container inside the doll. A touch of a concealed button and the doll speaks, whether standing, lying or sitting down.

The small, precision-built motor has to be held to a speed between 4350 and 4550 rpm in manufacture. It is impossible to measure its speed with a mechanical tachometer. Blake Manufacturing Corporation of Clinton, Massachusetts, who make the motors, use four STROBOTACS in test jigs to check the speed of these motors as they move through production. Any motor which does not meet the speed limits is rejected.

Simple test jigs hold Blake motors while their speeds are checked in three motor positions by STROBOTACS mounted above them. A small plastic sleeve, marked with a black indicating line is slipped over the motor shaft to be "stopped" by Strobotac measuring motor speed within 1%.



Type 631-B

STROBOTAC®

Direct-Reading Speed Range: *600-14,400 per minute, Stops motion 100 to 100,000 rpm*
Flash Duration: *between 5 and 10 millionths of a second.*
Power Source: *any 115 volt, 60 cycle line.*
Power Input: *25 watts.* **Size:** *7½ x 8¼ x 9.*
Weight: *9½ lbs.* **Price:** *$140.00*

To Blake, as to thousands of other manufacturers of electrical and mechanical equipment, the STROBOTAC has made possible entirely new manufacturing, designing and testing techniques. We'd like to suggest some of STROBOTAC'S possibilities to you.

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YOUR FIRST CHOICE for *severe service* conditions in piping is the TUBE-TURN Welding Neck Flange. It is engineered with a long tapered hub and a smooth transition in thickness to the pipe-end bevel. This means greater pressure-containing capacity under extreme temperature as well as much longer life than other types when repeated pipe bending or severe vibrations are involved.

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Write Dept. F-4 for free booklet, "Research on the Cyclic Life of Piping Systems."

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Underground tunnels at Cleveland's City Hospital contain the old and the new in piping. New 125-pound steam main (Fig. 1) serving several new buildings is welded. A welded system with TUBE-TURN Fittings was chosen to cut installation time, and to get tight, leakproof joints.

New welded line (Fig. 2) elbows neatly over an older pipe. When space is confined like this, welding is the answer. Contractor welded pipe from 2" up to 12" in tunnels, boiler room and power house.

With welding equipment on the job it's easier to put up pipe supports too. Eyebolt (Fig. 3) is quickly welded to TUBE-TURN Elbow, support rod hooked through it. This steam line to the water heaters must be secure.

Insulation on the maze of piping to the boiler feed pumps (Fig. 4) went up fast, with no flanges to work around. In such close quarters a neat design and reduced space requirements are especially important. And with the pipe welded to TUBE-TURN Fittings, joints won't leak, and insulation will last.

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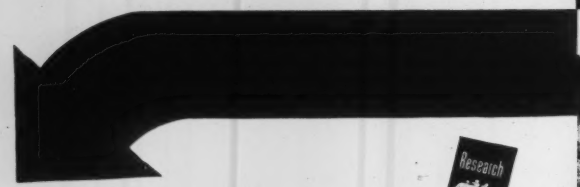

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Fig. 1. Welded underground steam main.

Fig. 2. New welded piping fits in small space.

Fig. 3. Support on steam line elbow.

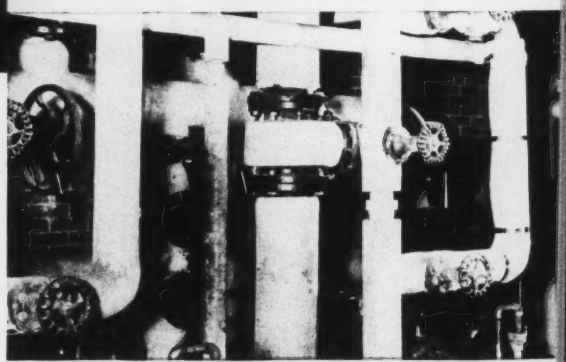

Fig. 4. Insulated welded piping.

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Sylphon bellows assemblies are used in many ways, in practically all industries . . . where there's a design problem involving control of temperatures and pressures. They open and close valves, dampers, etc., absorb expansion, provide packless construction, have many more uses.

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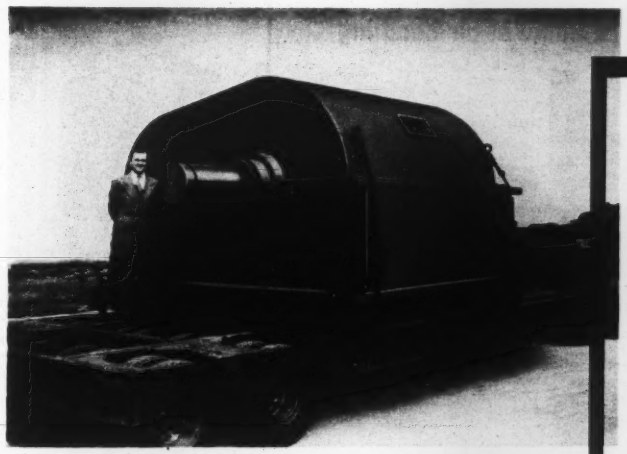
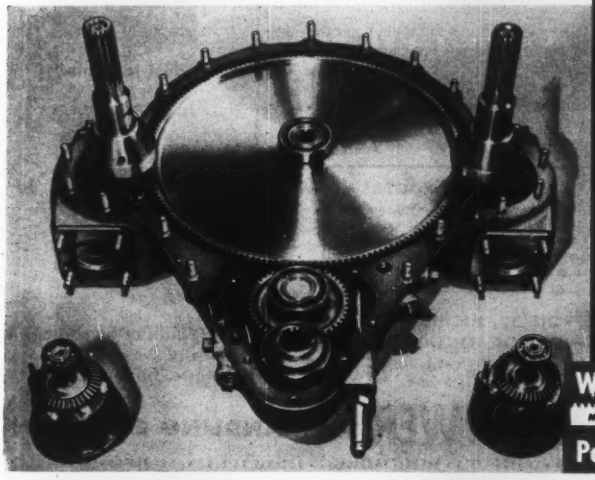


Here is an example of a large, special Pacific-Western transmission used for driving a dredge cutter head It weighs 75,000 pounds, is rated 1000 HP at 600 rpm input speed—with overload relays for operation up to 3000 HP. It operates at angles as much as 50 degrees off horizontal, partially submerged if necessary. The case is a weldment. The input gearing is herringbone, the output gearing is helical

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

In contrast to the dredge cutter drive is this precision-quality, air borne auxiliary, power-unit drive for an experimental project developed by Solar Aircraft Company. Powered by two gas turbines, the gear box drives an alternator, an exciter and six accessory pads. Input speed is 24,000 rpm, output speeds range from 3000 to 24,000 rpm Its starting-motor clutches allow the use of either or both turbines, and enables starting either turbine from the electric starter The gear train consists of highly loaded, hardened, alloy steel spur and bevel gears mounted on anti-friction bearings.



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COOLING . . .

American Blower's reputation for high quality has made them an important source of supply for many original equipment manufacturers. A leading maker of refrigeration equipment, for example, relies on American Blower almost exclusively for the fans and blowers used in his units. As he says: "We know refrigeration. You know air handling. Together, our teamwork and high standards of quality results in an end product second to none." Can you use the American Blower team in your field?

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Being able to eliminate a central heating system with self-contained gas-fired unit heaters is a big advantage in those small but neat new stores and shops springing up everywhere. American Blower Gas-Fired Unit Heaters are not only highly efficient but harmonize beautifully with modern interiors. A.G.A. -approved, they are available in a wide range of sizes to meet many different commercial needs. Our nearest branch office will give you complete data and prices.

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As an added sales feature for new homes and multiple dwelling units, builders find American Blower Aeropel Fans a natural. One builder recently installed 300 in a housing project. Found the response so good he's making them a standard feature. Aeropel Fans have won two Fine Arts Awards for beauty and utility in the home. They're ideal for ventilating kitchens, basements, recreation and utility rooms—are reasonably priced and easy to install.

MAY WE SERVE YOU?

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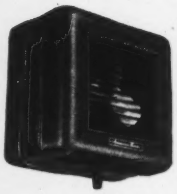
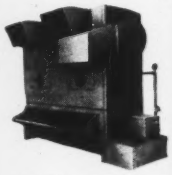
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO

Division of AMERICAN RADIATOR & Standard Sanitary CORPORATION

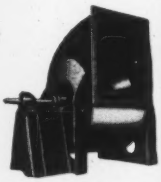


Unit Heaters

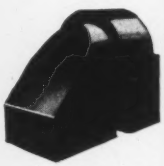
Ventura Fans



Air Conditioning Equipment



Industrial Fans



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Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS • DETROIT LUBRICATOR • KEWANEE BOILERS • ROSS HEATER • TONAWANDA IRON

No location problems—works underneath streets, parks, etc.

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Saves valuable space—no surface motor or pump house.

THE BJ SUBMERSIBLE PUMP HAS IMPORTANT INSTALLATION ADVANTAGES NOT OFFERED BY ANY OTHER PUMP

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Capacities to 20,000 gpm. Heads to 1500 ft.

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Can work beneath ice and away from atmospheric changes.

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Precision assembled at factory—installed without adjustments.

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The New FASTAX 8mm camera has a speed range from 300 to 14,000 pictures per second. The New FASTAX 16mm camera has a speed range from 150 to 7,000 pictures per second. The New FASTAX 35mm camera has a speed range from 500 to 5,000 pictures per second. Only with the FASTAX are such wide speed ranges obtainable.

The New FASTAX Camera Optics produce high resolution. The Wollensak name is your assurance of the finest in optical performance.

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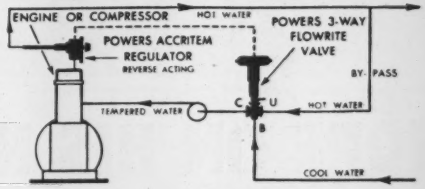
Before You Buy

JACKET WATER TEMPERATURE CONTROL

Investigate



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POWERS ACCRITEM REGULATOR and FLOWRITE DIAPHRAGM VALVE—
Compressed Air or Water Operated

— Provides positive, dependable control for large size 3-way or 2-way valves. ***Safety feature*** of hook-up above: failure of air or water pressure allows only cooling water to flow through the valve to engine.

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Complete Line of Dependable, Time-Tested Regulators

IMPORTANT ADVANTAGES that quickly pay back the cost of Powers self-operating and pneumatic controls for air compressors, diesel and gas engines:

- **Correct jacket water and lube oil temperature at all times, regardless of load or seasonal changes.**
- **Improved lubrication and cylinder liner wear.**
- **Fewer piston ring replacements.**
- **Saves Labor; increases efficiency.**
- **Reduces danger of piston seizure.**
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Cost of Powers jacket water temperature control? About the same as a set of new piston rings. Powers regulators are unsurpassed for reliability and years of trouble free service.

Have a POWERS Engineer call to study your requirements for better jacket water temperature control. There's no obligation. Phone or write our nearest office.

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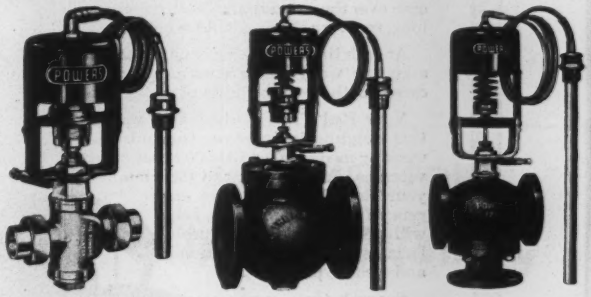
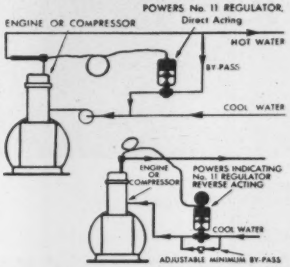
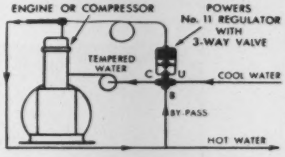
(DIG)

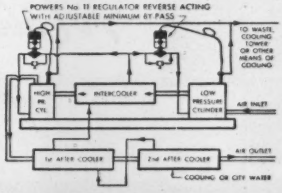
No. 11 Self-Operating TEMPERATURE REGULATORS

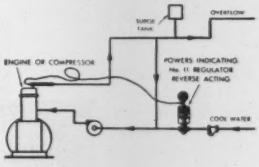


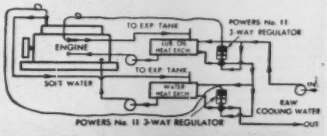
Provide dependable control for most applications. They're simple, ruggedly built, economical and easy to install. Especially suited for air compressors, diesel and gas engines. Temperature indicating regulator also available.






POWERS No. 11 REGULATOR REVERSE ACTING WITH ADJUSTABLE MINIMUM BY-PASS
TO WASTE, COOLING TOWER OR OTHER MEANS OF COOLING
HIGH PR. CYL.
INTERCOOLER
LOW PRESSURE CYLINDER
AIR INLET
1st AFTER COOLER
2nd AFTER COOLER
AIR OUTLET
COOLING OR CITY WATER





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It takes more than our government's fine medical treatment to ease a disabled veteran over the rough spots. Often days seem long, recovery slow, the future hopeless.

At such times, a helping hand, an understanding word—*knowing that somebody cares*—is the best medicine of all.

Your Red Cross workers now provide this neighborly interest, this miracle-working medicine for 134,000 hospitalized veterans. For veterans and their families, your Red Cross also gives emergency financial assistance, helps with personal and family problems, engages in recreational and welfare programs.

Support these worthwhile activities by giving to your Red Cross. Give now—and give *generously!*

Mobilize for defense give now!

The TERRY TURBINE

TURBINES FOR *Air Conditioning* AT MADISON SQUARE GARDEN

In 1925 Madison Square Garden installed three Terry Multi-Stage Turbines to drive air conditioning and refrigeration compressors. These units deliver 290 hp at 3500 rpm with steam conditions of 100 psi exhausting to a 26 in. vacuum.

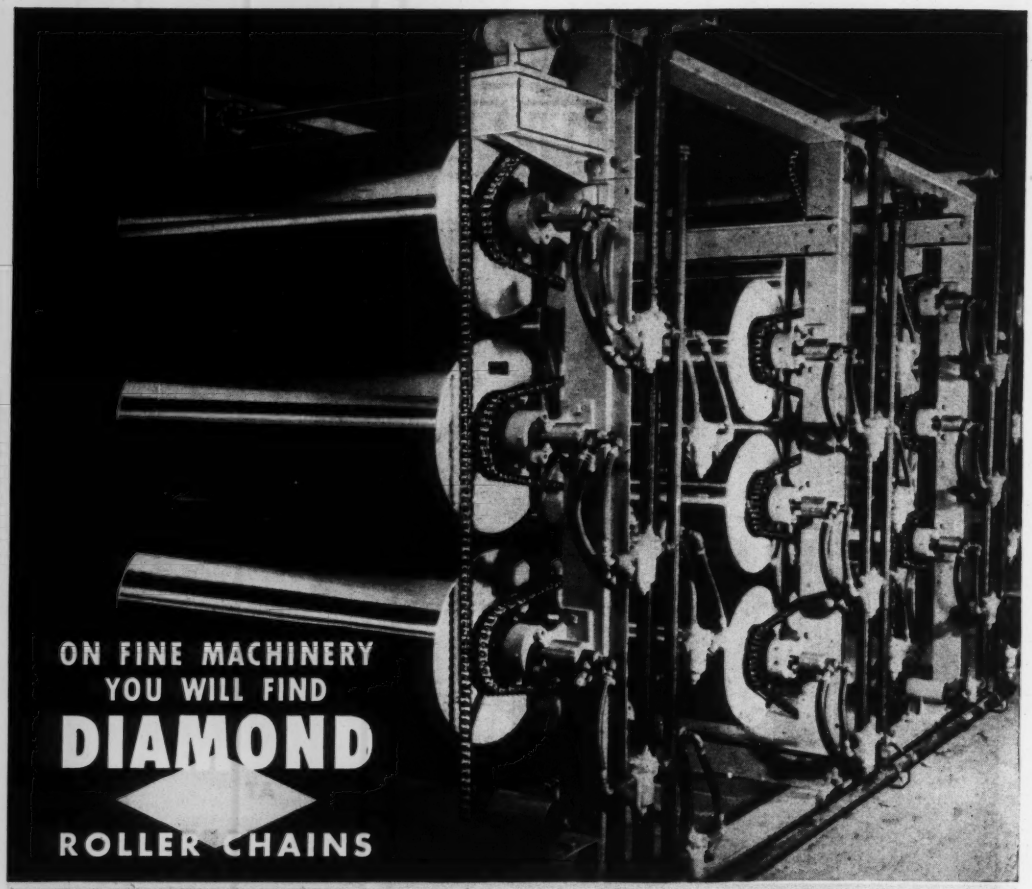
After 22 years experience Madison Square Garden installed three more Terry Multi-Stage Turbines, one of which is shown above. This unit delivers 330 hp, at 5650 rpm, with steam at 100 psi exhausting to a 25 in. vacuum.

The same engineering talent and manufacturing facilities that produced these turbines are available to assist you in obtaining efficient power generation.

Any of our District Representatives will be pleased to give you full information on a turbine drive for your requirements. No obligation. May we send you descriptive bulletin?

TT 1184

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.



A GOOD EXAMPLE OF DIAMOND ROLLER CHAIN APPLICATION ON NEW DRY CAN, THE TEXTILE SHOPS, SPARTANBURG

Experienced Engineers Respect Good Engineering

An instinctive desire to create the finest is common among machinery engineers and builders. It is the reason why these men respect good engineering and quality in the selection of all parts.

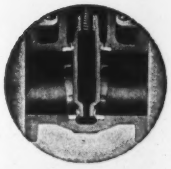
At Diamond, good engineering has been applied continuously for over 60 years on one thing, progress in the making and applying of Roller Chains and Sprockets.

As a result, on leading makes of all kinds of machinery, Diamond Roller Chains have been widely used and continue to be used. The "Diamond" trade mark is accepted the world over as the mark of quality by machinery buyers and users.

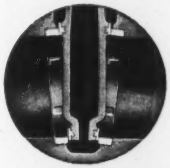
Engineers will find the constructive suggestions made by our specialized engineering staff of worthwhile help . . . DIAMOND CHAIN COMPANY, Inc., Dept. 413, 402 Kentucky Avenue, Indianapolis 7, Ind. *Offices and Distributors in All Principal Cities.*

DIAMOND ROLLER CHAINS

PROPERLY ENCASED. ALL DANGER OF PRODUCT DAMAGE THROUGH LUBRICATION THROW-OFF OR "SPATTER" IS AVOIDED



Straight-Flow Port Design reduces fluid turbulence to a practical minimum.



Seat Rings of end-seated type are screwed into the body.

Sure-Grip Malleable Handwheel for non-skid gripping even with heavy gloves.

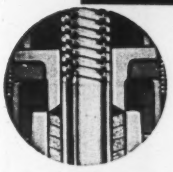
WALWORTH

iron body gate valves

with screwed or flanged ends

... 8 Outstanding Features

For complete information on these new Walworth Iron Body Valves, see your local Walworth distributor, or write for bulletin 106.



Brass Liner on Glands assures greater resistance to corrosion and scoring.

WALWORTH

valves and fittings

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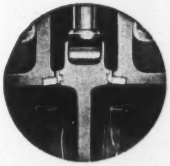
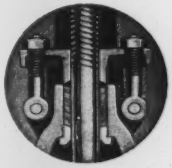
DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD



T-head Disc-to-Stem connection on OS&Y types provides stronger connection, prevents loosening of disc by corrosion.

Bronze Back-Seat Bushings bonnets of OS&Y valves.

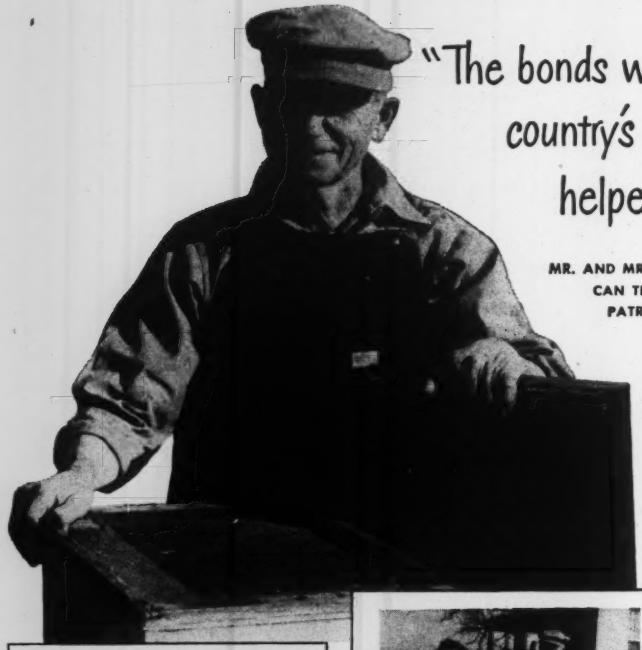
Solid Web Type Disc in OS&Y valves for greater strength and longer service.



Hinged Gland Eye-Bolts on OS&Y valves permit faster, easier repacking under full pressure.

"The bonds we bought for our country's defense bought and helped equip our farm!"

MR. AND MRS. CHARLEY L. WHATLEY OF CUTHBERT, GA. CAN TELL YOU—IT'S PRACTICAL AS WELL AS PATRIOTIC TO BUY BONDS FOR DEFENSE



Mr. Whatley inspects a beehive on his 202-acre farm. "I wouldn't own a farm, clear, today," he says, "if it weren't for U. S. Savings Bonds. We bought a new truck, refrigerator and electric range, too. I've discovered that bonds are the best way of saving for a working man."

Mr. Whatley says, "My wife and I bought our first bonds in 1943, through the Payroll Savings Plan at the Martha Mills plant of the B. F. Goodrich Co. in Thomaston. Our pay averaged $40 a week apiece and we put about a quarter of that amount into U. S. Savings Bonds."

"We'd saved $6,925 by 1950. $4,000 bought us our 202-acre farm and a 6-room house. Then we bought a new truck, a refrigerator and electric range. Now Mrs. Whatley has time for tending her flowers while I can enjoy my hobby of bee-keeping. We owe it all to *planned* saving."

"We're still holding bonds, too. We don't believe that anyone should cash his bonds unless he has to, so we're holding about $1,800 worth. With that cash reserve, and our farm clear, we can grow old with comfort and peace of mind. Everybody should buy U. S. Savings Bonds!"

The Whatleys' story can be your story, too!

You can make your dream come true, too—just as the Whatleys did. It's easy! Just start *now* with these three simple steps:

1. Make one big decision—to put saving *first*, before you even draw your pay.

2. Decide to save a regular amount *systematically*, week after week or month after month. Even small sums saved on a systematic basis, become a large sum in an amazingly short time!

3. Start saving automatically by signing up *today* in the Payroll Savings Plan where you work or the Bond-A-Month Plan where you bank. You may save as little as $1.25 a week or as much as $375 a month. If you can set aside just $7.50 weekly, in 10 years you'll have bonds and interest worth $4,329.02 cash!

You'll be providing security not only for yourself and your family but for the free way of life that's so important to us all. And in far less time than you think, you'll have turned your dreams into reality, just as the Whatleys did.

U. S. SAVINGS BONDS ARE DEFENSE BONDS —BUY THEM REGULARLY!

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Yes, sir! With a du Mont "Minute Man" Keyway Broach Kit you can cut any standard keyway from ⅛" to 1" in any bore from ¼" to 3" by hand, in one minute, for as little as a penny a keyway — at most a few cents. Think what it costs you to cut 'em any other way!

Get the facts on this great little time and money saver.

MAIL THIS COUPON

The du MONT CORPORATION, Greenfield, Mass.

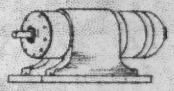
Please mail "Minute Man" Keyway Broach Kit information and price list ME

Name .....

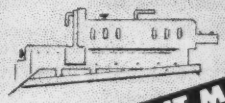
Company .....

Address .....

A PERFECT TRIO.

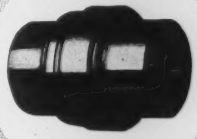


A POWERFUL MOTOR .....



AN EFFICIENT MACHINE ....

AND A **LOVEJOY** COUPLING IN BETWEEN



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LOVEJOY FLEXIBLE COUPLING CO.

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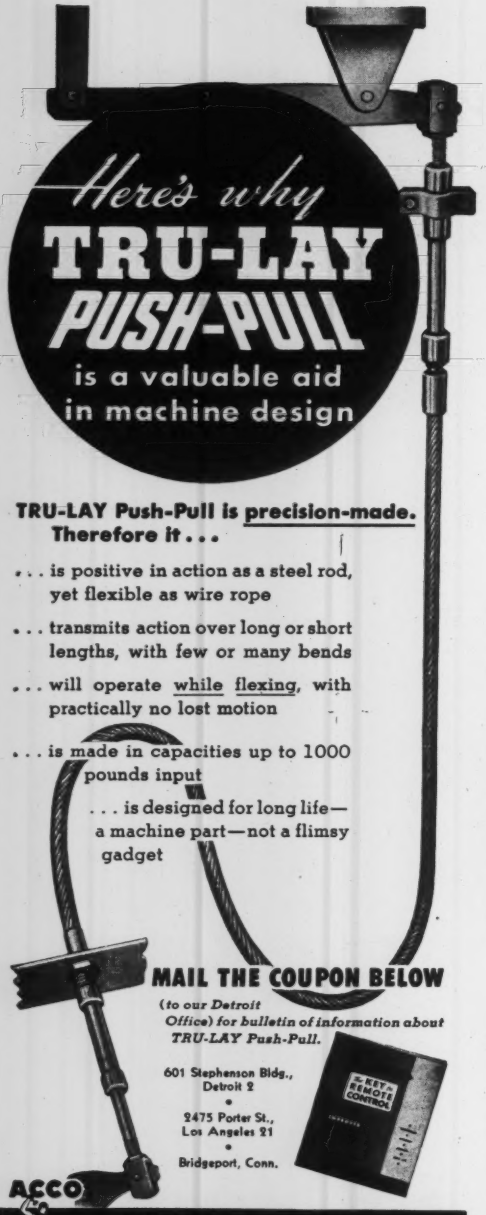
Also Mfrs. Lovejoy Universal Joints and Lovejoy Variable Speed Transmissions.



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TRU-LAY PUSH-PULL

is a valuable aid in machine design

TRU-LAY Push-Pull is precision-made. Therefore it . . .

. . . is positive in action as a steel rod, yet flexible as wire rope

. . . transmits action over long or short lengths, with few or many bends

. . . will operate while flexing, with practically no lost motion

. . . is made in capacities up to 1000 pounds input

. . . is designed for long life—a machine part—not a flimsy gadget

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AMERICAN CHAIN & CABLE

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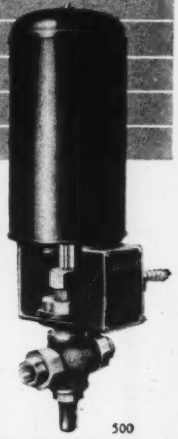
SARCOSTAT

THE NEW HYDRAULIC OPERATOR



Operated by direct thrust of a neoprene-sealed plunger actuated by oil pressure—no pilots, gears or multiplying levers.

Available for open-and-shut or two-step control from any two wire switch—pressure, temperature, liquid level, etc.

Moisture proof and suitable for control of steam, water or air. The valve operating mechanism is adaptable for use in positioning of levers or dampers.

Full information in Bulletin 1081.

500

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SARCO COMPANY, INC.

Represented in Principal Cities

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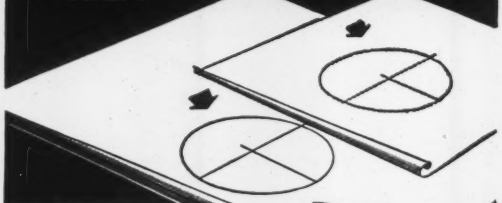
SARCO CANADA, LTD., TORONTO 5, ONTARIO

IMPROVES PRODUCT QUALITY AND OUTPUT

Imperial

TRACING CLOTH THAT DEFIES TIME



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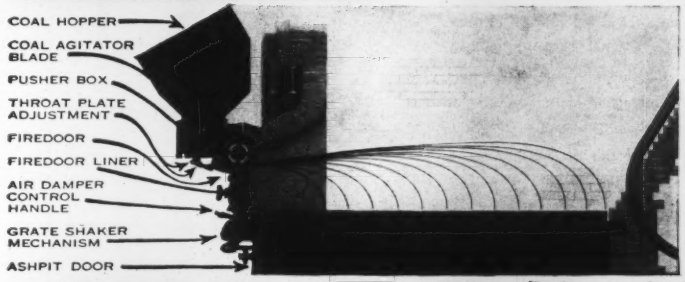
To achieve better overall firing conditions consult with our engineers.



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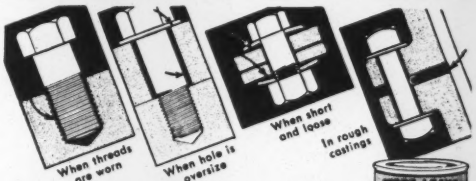

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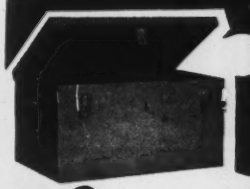

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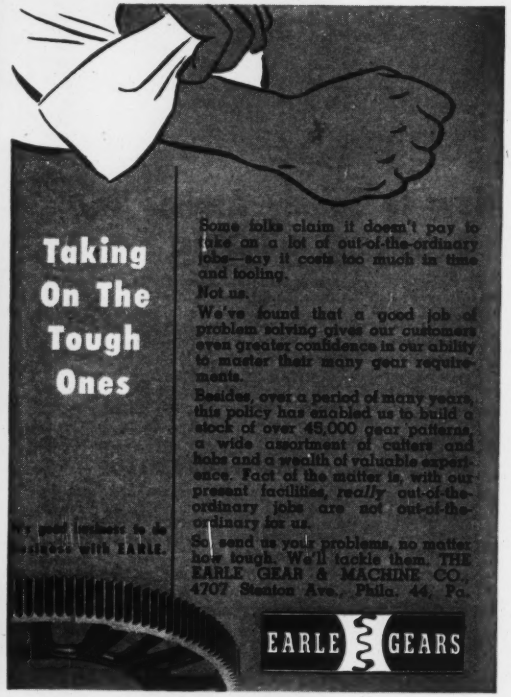
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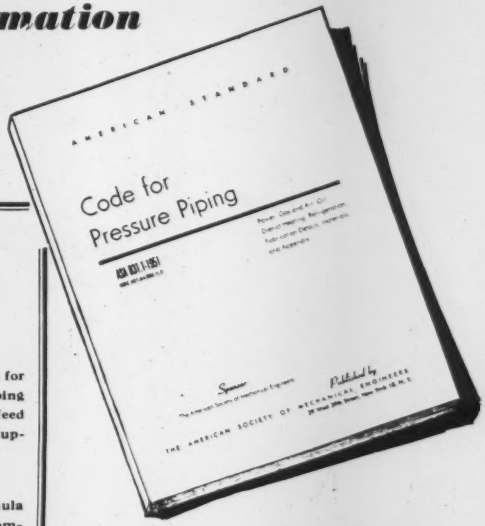

Principal Amendments and New Requirements incorporated in this 1951 REVISION include:

In Section 1—POWER PIPING SYSTEMS, there are new requirements for hydrostatic tests of steel valves and fittings before erection and of piping systems after erection . . . revisions that permit designing boiler feed piping to conform to the adjusted temperature—pressure ratings of Supplement 1 of the B16e-1939 Standard.

Section 2—GAS AND AIR PIPING SYSTEMS now has a revised Formula 3 . . . . new provisions affecting wall thickness of pipe in gas and air compression systems . . . new rules requiring pipe other than cast iron and nonferrous tubing to be capable of qualification for maximum allowable working pressures at least equal to the pressures prescribed for pipes of various yield strengths.

The scope of Section 3—OIL PIPING SYSTEMS has been clarified . . . the modified Lamé formula is now the primary basic formula for wall thickness while the modified Barlow formula is retained as an alternate . . . all tables of pressure-temperature ratings agree with those in Supplement 1 of the B16e-1939 Standard . . . allowable stress values are included for API 5LX pipe and other materials that meet higher service conditions . . . there are provisions for pressure seal valve bonnets and welded bonnets . . . permission to use block valves between pressure vessels and their relief valves under specific conditions.

Obsolete requirements, specifications, and tables have been eliminated from Section 4—DISTRICT HEATING PIPING SYSTEMS . . . all tablescontinued have been brought up-to-date . . . material specifications that have become available since the last revision are included.

Chief changes in Section 5—REFRIGERATION PIPING SYSTEMS are those affecting the requirements for specific minimum thickness of refrigerant pipe and tubing.

In Section 6—FABRICATION DETAILS, the welding rules of the ASME Boiler Code are now embodied in the welding requirements . . . illustrations and examples are inserted to show the application of these rules for reinforcement of welded branch connections . . . there are amended expansion and flexibility requirements.

Section 7—MATERIALS, THEIR SPECIFICATIONS AND IDENTIFICATION includes requirements for marking component parts of piping systems and a statement of the Committee's policy in making reference to standards and specifications . . . . allowable stress values have been transferred to the sections for various piping systems.

Rules for INSTRUMENT AND CONTROL PIPING now contain specifications for flared and compression type fittings . . . separate requirements for take-off connections, reservoirs, and shut-off valves.

Committees representing engineering and trade associations, government bureaus, and equipment manufacturers worked for more than two years on the revision of the 1942 edition. They have rewritten most of the text, amended many of the requirements, amplified others, eliminated rules that have become obsolete, and incorporated much new material. The result is the 1951 Code providing up-to-date requirements for:

- Selection of suitable materials and reference to standard specifications by which they may be secured.
- Designation of proper dimensional standards for the elements comprising piping systems.
- Design of the component parts as well as the assembled unit including necessary supports.
- Erection of these systems.
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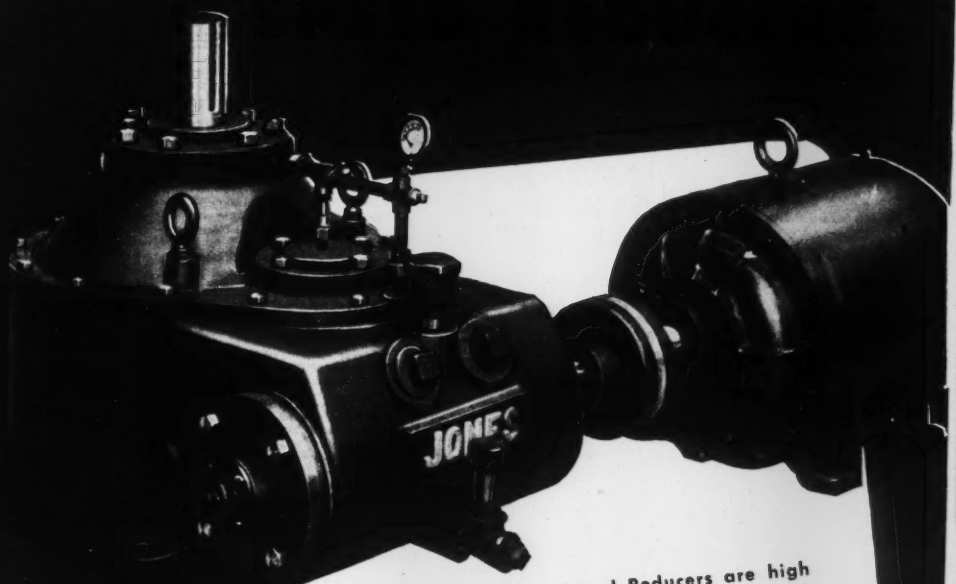

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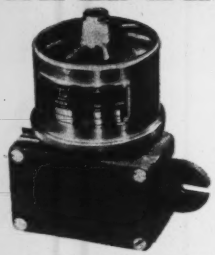

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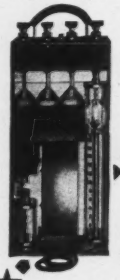

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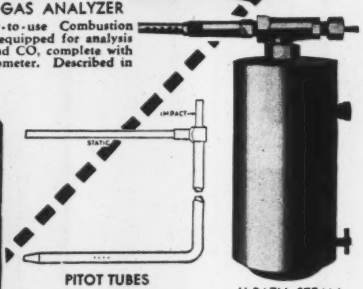

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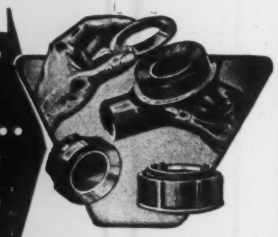

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MECHANICAL ENGINEERING

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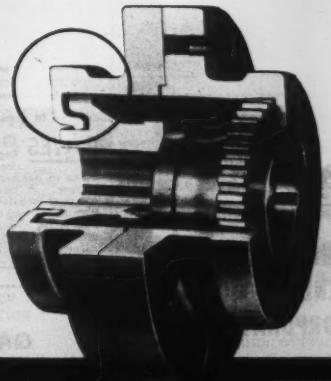

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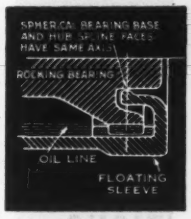

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*Aetna Ball & Roller Bearing Co.
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*Armstrong Machine Wks.
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*Bailey Meter Co.
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*Cochrane Corp.
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*Wickes Boiler Co., Div. of Wickes Corp.
*Wing, L. J., Mfg. Co.
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MECHANICAL ENGINEERING, 29 W. 39th St., New York 18, N. Y.

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Address _____

City _____ State _____

Reader Service Coupon For More Information

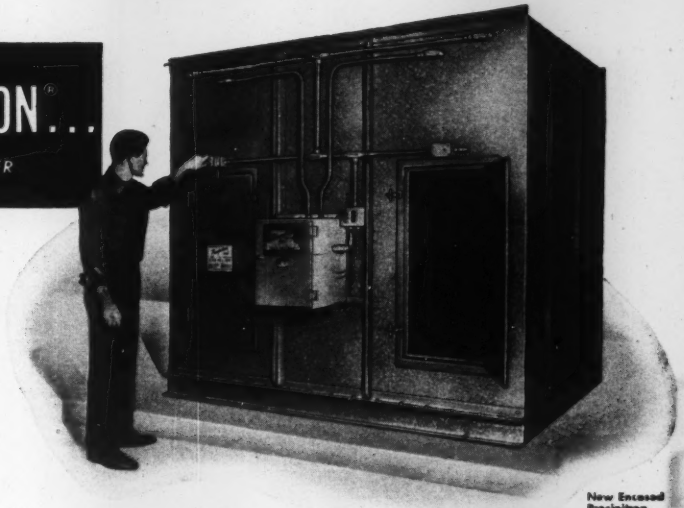
Go through the advertising pages and jot down the page numbers and names of advertisers about whose product you want additional information — mail the coupon to us — your request will be passed on to the advertiser promptly — you will hear directly from advertiser — saves your time in writing individual letters.

NOW PRECIPITRON®...

THE ELECTRONIC AIR CLEANER

IS AVAILABLE AS A COMPLETE "PACKAGE"

Saves You



New Encased Precipitron Electronic Air Cleaner

MATERIAL PROCUREMENT • ENGINEERING EXPENSE
INSTALLATION EXPENSE • TIME AND MANPOWER

Westinghouse PRECIPITRON, the electronic air cleaner, has long been used where clean air is a *must*. Its wide acceptance is due to three factors: (1) its design—*invented* by Westinghouse and developed through years of engineering and application experience; (2) its efficiency—*three times* more efficient than the *best* mechanical air cleaner; (3) its dependability—proved by countless installations.

In industrial plants, rejects, soilage and substandard work caused by airborne dirt and foreign matter are eliminated by PRECIPITRON. Circulating air for individual machines, for single rooms, or for large areas of your plant or office buildings can be made free of dust, dirt, pollen, and oil mist.

NOW, Westinghouse announces a new model which incorporates all the features of the standard line, and adds the convenience and money-saving advantages of a factory-designed, factory-matched *encased* unit.

HERE'S WHAT IT MEANS TO YOU:

Material Procurement Reduced. Everything you need is provided . . . no searching for scarce parts or supplies, or resorting to substitutes . . . 18-gauge casing and 10-gauge tank of galvanized steel assure rigidity; entering side baffles provide proper air distribution.

Eliminates Layout and Enclosure Design. Complete unit available in capacities from 8,000 to 44,000 cfm comes ready for assembly at the site . . . flanges punched for duct connections . . . sealed access doors with safety interlocks are pre-installed . . . all parts fit . . . even the hardware is included!

Masonry Work Reduced or Eliminated. Drain tank for flushing away collected dirt lays into place and unit bolts to it . . . range of 24 sizes from 8' x 5' x 5' to 8' x 10' x 11' permits matching to the job.

Saves Time and Manpower. Prefabricated parts, factory-matched, save assembly time and assure proper installation . . . highly skilled labor not required.

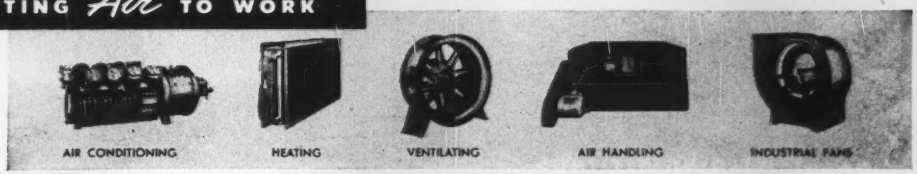
Read about these and many other benefits such as accessibility, ease of maintenance, and undivided responsibility. Ask for application data DB 93-820 TODAY, and see for yourself how the PRECIPITRON Encased Unit can save you money. Westinghouse Electric Corp., Sturtevant Division, 138 Damon St., Hyde Park, Boston 36, Mass.

Write for booklet DB 93-820 today!

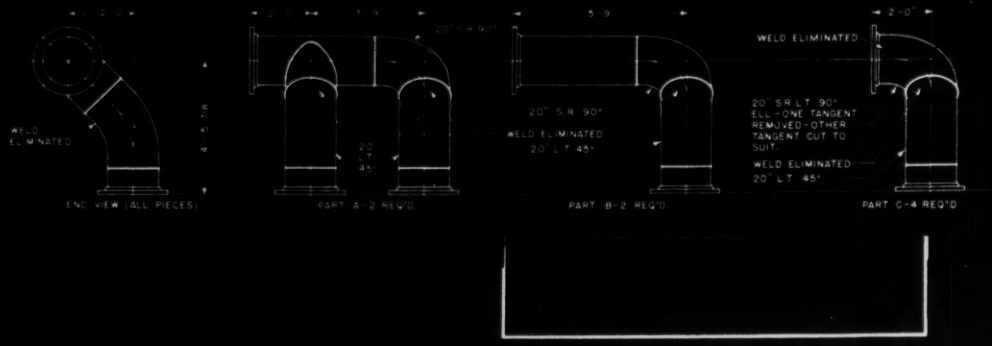
YOU CAN BE SURE...IF IT'S **Westinghouse**

J-80210B

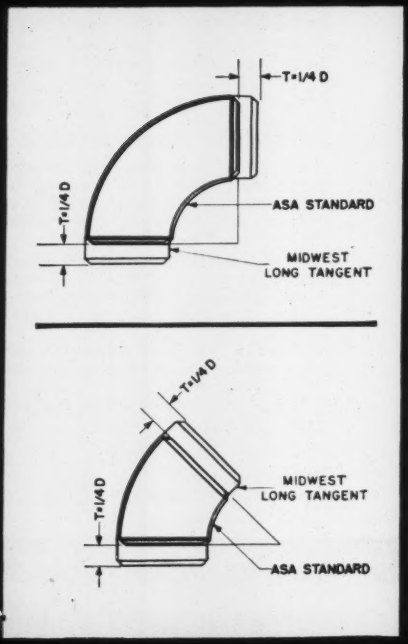
PUTTING *Air* TO WORK



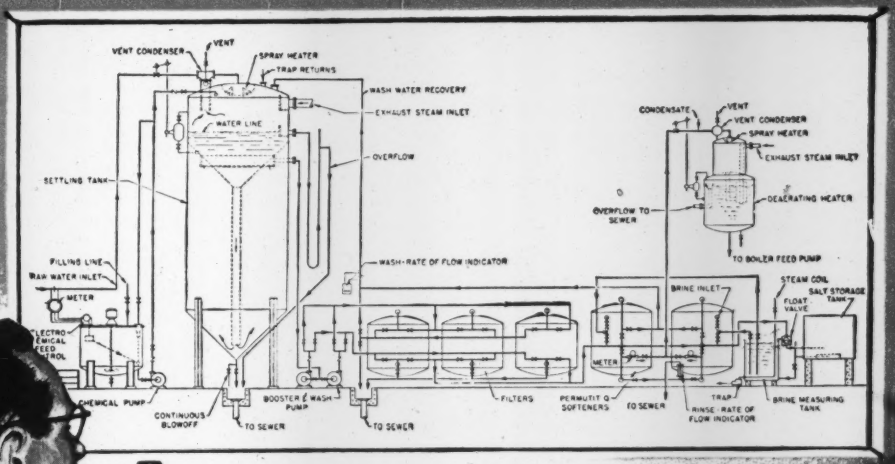
COST REDUCTION.



MIDWEST



MIDWEST WELDING FITTINGS
Improve Piping Designs and Reduce Costs



"...have you heard about Permutit's New Hot Zeolite Process?

"Permutit announced the process only a few months ago, but already we're putting it to good use in our plant. We think it's the best way of producing water that's low in alkalinity and silica . . . and with all hardness removed."

"Say, Ed, that's really something . . . getting an effluent of zero hardness from a hot lime soda softener! How's it possible?"

"Well, you see, Joe, they've developed a new mineral, Permutit Q. It's an ion exchanger that will withstand boiling water with a pH over 10, and it's not affected under operating conditions like that even after 1300 regeneration cycles."

"Tell me more! Is Permutit Q more economical than phosphate?"

"It is, and what's more, it reduces CO_2 in the steam. I'm really sold on this new process, because our chemical costs are lower, our effluent is lower in alkalinity and total solids, and we don't need acid feeding to prevent deposits in our high stage heaters and economizers."

"The more you tell me, Ed, the more I want to know. I think we could put this new hot zeolite process to work in our plant, too. How can I find out full information about it?"

"If you write to Permutit, they'll send you a new bulletin *full* of information. I have their address somewhere . . . oh yes! It's The Permutit Company, Dept. ME4, 330 West 42nd Street, New York 18, N. Y. Then there's the Permutit Company of Canada, Ltd. at 6975 Jeanne Mance Street, Montreal."

"Thanks for the tip, Ed. I'm sending them a letter today!

Water Conditioning Headquarters for Over 37 Years

PERMUTIT

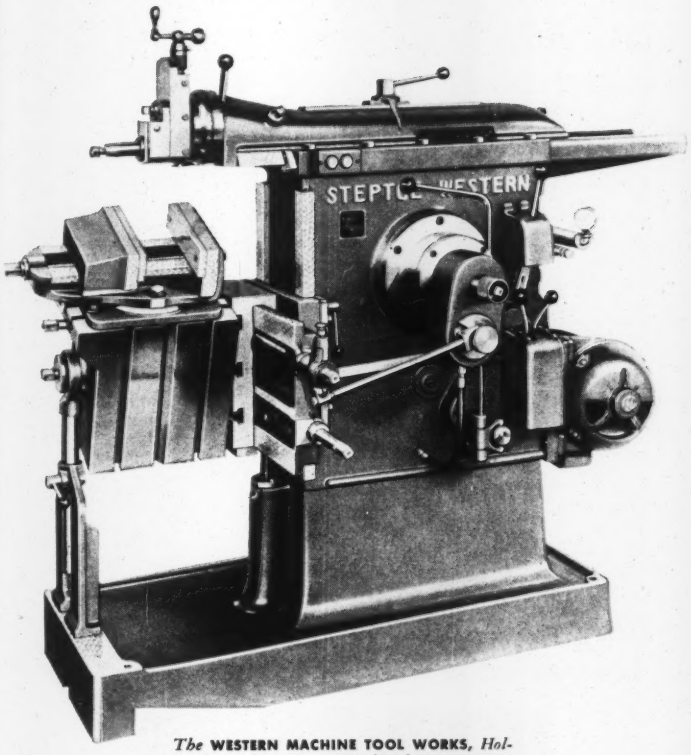
High speed shaper keeps in shape with TIMKEN® bearings

THIS Steptoe-Western 15" shaper is one of the fastest precision shapers in its class. It has 18 ram speeds and works up to 200 strokes per minute. To insure precision and trouble-free operation, the Western Machine Tool Works has mounted the input shaft, three countershafts, and the main bull gear on Timken® tapered roller bearings—a total of 12 in all, with automatic pressure lubrication.

Timken bearings keep shafts in rigid alignment under the heaviest loads. Tapered construction enables them to take any combination of radial and thrust loads. Line contact between rollers and races gives them extra load-carrying capacity.

Manufactured to extreme precision and finished to incredible smoothness, Timken roller bearings make friction practically negligible. And since they're made of the finest steel ever developed for tapered roller bearings—Timken fine alloy steel—they last the life of the machine.

With 50 years of bearing research and development back of them, Timken bearings are first choice throughout all industry. No other bearing can give you all the advantages you get with Timken bearings. Look for the trade-mark "Timken" on every bearing you use. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".



The **WESTERN MACHINE TOOL WORKS,** *Holland, Michigan, uses Timken bearings in its 12" and 15" shapers to insure consistent precision and trouble-free performance for the life of the machine.*

This symbol on a product means its bearings are the best.

FINISHED TO CLOSER TOLERANCES

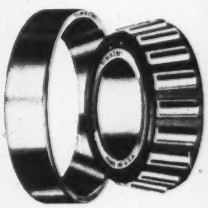
Finishing to incredible smoothness accounts for much of the precise, smooth rolling performance of Timken bearings. This honing operation is typical of the amazingly accurate manufacturing methods at the Timken Company.

The Timken Company is the acknowledged leader in: 1. advanced design; 2. precision manufacturing; 3. rigid quality control; 4. special analysis steels.

TIMKEN

TRADE MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL NOT JUST A ROLLER THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION